The Engineer

LONDON, FRIDAY, JULY 18, 1941.

PUBLIC NOTICES

AUCKLAND HARBOUR BOARD, NEW ZEALAND

TEN FIVE-TON ELECTRIC SEMI-PORTABLE JIB CRANES

Tenders Will be Received at the Office of the Board at Auckland, N.Z., up till Twelve Noon on Tuesday, 30th September, 1941, for the SUPPLY and DELIVERY of TEN 5-TON ELECTRIC SEMI-PORTAL JIB CRANES, in terms of Specification No. 1152, which may be seen at the Office of the Board's Agent, Mr. C. R. Butters, c/o Messrs. H. H. Lloyd and Co., 2A, Guildhall Chambers, 31, Basinghall Street, London, E.C.2.

(Sgd.) W. B. SMITH,
Secretary.

7584

CITY AND ROYAL BOROUGH OF DUNDEE

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Applications are Invited for the above APPOINTMENT from experienced Engineers of an age preferably not over 40, at a salary in accordance with the National Joint Board Schedule, Class H, Grade 6, at present £488 per annum. A 30,000-kW extension is nearing completion.

The appointment will be subject to the provisions of the Local Government Superannuation Act, 1937, and the selected candidate will be required to pass a medical examination.

Applicants must have a sound theoretical knowledge and considerable practical training and experience in the operation and maintenance of large modern high-pressure boilers, fuel and ash-handling plant, turbo-alternators and their associated auxiliaries. The successful candidate will be required to take charge of all overhauls and repairs, and must have the initiative and resource necessary for organising and expeditiously carrying out such work and for dealing promptly with emergencies, as well as boiler and turbo-alternator efficiency tests. A thorough knowledge of the principles of fuel combustion and steam generation is also essential, and he would also be expected to assist the generation engineer in any special matters relating to the running of the station.

Applications, stating age, full particulars of theoretical and mechanical training, experience and qualifications and accompanied by copies of recent testimonials, should be forwarded to the undersigned.

D. H. BISHOP, B.Sc., M.I.E.E.,
General Manager and Engineer.

Dudhope Crescent Road,
Dundee,
11th July, 1941. 7620

WOOLWICH POLYTECHNIC, LONDON, S.E.18

LECTURER IN CIVIL AND MECHANICAL ENGINEERING

The Governing Body Invite APPLICATIONS for the POST of LECTURER in CIVIL and MECHANICAL ENGINEERING, duties to commence on the 1st September. Salary up to £528 per annum, according to teaching, research and industrial experience. Candidates should have industrial, design and laboratory experience, and preference will be given to those who can qualify to become recognised teachers of the University of London.

Particulars of the appointment and forms of application may be obtained from the SECRETARY on receipt of a stamped addressed envelope.

Closing date 30th July, 1941. 7617

SITUATIONS OPEN

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TO ADVERTISERS UNDER BOX NUMBERS IN SITUATIONS OPEN SECTION.

For the benefit of applicants, the Proprietors are prepared to insert brief notices that vacancies are filled, upon receipt of notifications from the Advertisers. These notices (limited to one line) will be free of charge, and co-operation is asked for.

IMPORTANT

Advertisers in Situations Open Column should make themselves acquainted with the terms of

STATUTORY RULES & ORDERS 1940 No. 877

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The Engineer

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IMPORTANT NOTICE

All correspondence dealing with Editorial, Advertising and Subscription Matters should be addressed to: 28, ESSEX STREET, STRAND, LONDON, W.C. 2

Remittances and Letters dealing with Accounts should be sent to:

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***c/o* The Pitman Press,**
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Bath, Somerset.

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THE PROPRIETORS of BRITISH PATENT No. 485,546, dated November 30, 1937, relating to "Improvements in Nut Tapping Machine," are DESIROUS of ENTERING into ARRANGEMENTS by way of a LICENCE or otherwise on reasonable terms for the purpose of EXPLOITING the above patent and ensuring its practical working in Great Britain.—Inquiries to SINGER, EHLERT, STERN & CARLBERG, Chrysler Building, New York City, N.Y., U.S.A. 7613 H

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CLASSIFIED ADVERTISEMENTS CLOSE FOR

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The Engineer
Annual Subscription Rates

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"THE METALLURGIST."

This Supplement, which deals with the Science and Practice of Metallurgy, both ferrous and non-ferrous, is published free with the last issue of THE ENGINEER each alternate month. Next date, August 29th.

ADVERTISEMENTS.

The charges for Classified Advertisements are 1/- per line up to one inch—minimum charge 4/-; those occupying one inch or more at the rate of 12/- per inch. Orders must be accompanied by a remittance. The rates for Displayed Advertisements will be forwarded on application. Classified Advertisements cannot be inserted unless delivered before TWO o'clock on Wednesday afternoon.

Letters relating to the Advertisement and the Publishing Departments of the Paper are to be addressed to the Publisher, all other letters are to be addressed to the Editor of THE ENGINEER.

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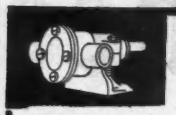

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"The Engineer" will be glad to receive catalogues, lists of manufacturers' trade names, etc., from firms for inclusion in the files of the Enquiry Department.

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560 ft.	16·0	×	14·0 mm.	·629″	×	·550″
130 ft.	17·3	×	13·6 mm.	·681″	×	·536″
1173 ft.	18·0	×	14·6 mm.	·708″	×	·575″
775 ft.	18·0	×	16·0 mm.	·708″	×	·629″
174 ft.	23·2	×	17·6 mm.	·913″	×	·693″
705 ft.	24·0	×	19·7 mm.	·945″	×	·776″
1530 ft.	25·3	×	21·5 mm.	·996″	×	·846″
1360 ft.	27·3	×	23·5 mm.	1·075″	×	·913″
440 ft.	28·3	×	23·0 mm.	1·114″	×	·905″
350 ft.	29·8	×	23·5 mm.	1·173″	×	·925″
700 ft.	33·3	×	26·5 mm.	1·311″	×	1·043″
123 ft.	36·3	×	29·4 mm.	1·429″	×	1·157″
1460 ft.	40·3	×	31·2 mm.	1·586″	×	1·228″
110 ft.	40·3	×	34·5 mm.	1·586″	×	1·358″
278 ft.	44·3	×	35·2 mm.	1·744″	×	1·385″
13 ft.	45·0	×	26·0 mm.	1·771″	×	1·023″
18 ft.	48·3	×	39·2 mm.	1·901″	×	1·543″
43 ft.	50·3	×	32·0 mm.	1·980″	×	1·260″
37 ft.	50·3	×	33·5 mm.	1·980″	×	1·319″
140 ft.	50·3	×	39·0 mm.	1·980″	×	1·535″
27 ft.	50·3	×	44·5 mm.	1·980″	×	1·752″
595 ft.	52·5	×	45·3 mm.	2·067″	×	1·783″
215 ft.	54·5	×	47·3 mm.	2·146″	×	1·862″
10 ft.	55·5	×	44·0 mm.	2·185″	×	1·732″
156 ft.	57·5	×	50·3 mm.	2·264″	×	1·981″
65 ft.	58·3	×	51·9 mm.	2·295″	×	2·043″
72 ft.	59·0	×	50·7 mm.	2·323″	×	1·996″
25 ft.	60·5	×	38·0 mm.	2·382″	×	1·496″
50 ft.	60·5	×	49·0 mm.	2·382″	×	1·929″
28 ft.	62·5	×	48·8 mm.	2·461″	×	1·921″
160 ft.	63·0	×	57·0 mm.	2·480″	×	2·240″
24 ft.	65·7	×	59·0 mm.	2·587″	×	2·322″
68 ft.	67·5	×	59·3 mm.	2·657″	×	2·334″
26 ft.	68·2	×	62·1 mm.	2·687″	×	2·445″
35 ft.	68·5	×	53·5 mm.	2·697″	×	2·106″
19 ft.	70·5	×	58·8 mm.	2·776″	×	2·303″
23 ft.	71·0	×	66·7 mm.	2·795″	×	2·625″
50 ft.	75·5	×	63·8 mm.	2·972″	×	2·512″
42 ft.	85·5	×	68·3 mm.	3·366″	×	2·689″
29 ft.	92·2	×	81·0 mm.	3·630″	×	3·189″

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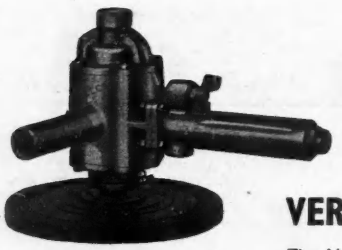

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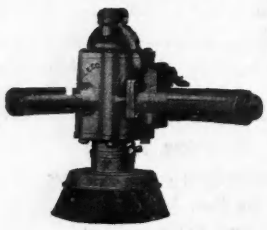

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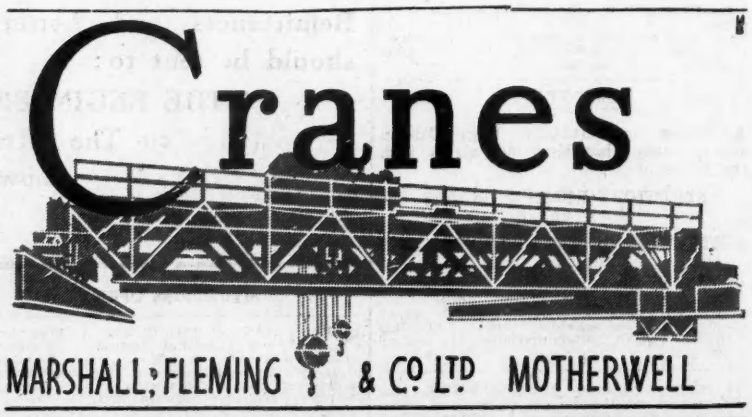

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A Seven-Day Journal

Safety of Life at Sea

INCREASED measures for safety of life at sea have been adopted in order to give greater protection and comfort to occupants of lifeboats and rafts. The measures are to be made compulsory wartime requirements under the Merchant Shipping Acts. On Wednesday, July 9th, a memorandum was circulated by the Minister of War Transport to organisations representing employers and employed in the shipping industry. The new requirements are the latest improvements in a long series of devices and measures which have been introduced since the piratical war on shipping was added to the ordinary perils of the sea. Among the more important measures already adopted are the provision of portable wireless apparatus from which an automatic distress signal may be given by an unskilled person; the development and supply of emergency rafts; the introduction of life-saving waistcoats; the development of self-igniting buoyant electric lights for attachment to rafts and lifebuoys and waistcoats; and the fitting of engines to lifeboats of certain ships. To these are now added the provision of hand pumps; protection from wind and sea for occupants of rafts; supply of oil to facilitate massage of feet and legs to prevent frost bite and "trench feet"; increased rations of water; and food of much greater nutritional value. The necessary arrangements with manufacturers of the new foods are well advanced, and no delay in supply is anticipated. Chocolate is being specially manufactured and will contain a thirst quencher. A bulk order has been placed by the Ministry for the manual pumps to be supplied to lifeboats and deliveries are expected to begin in a few days' time. Bulk orders will also be placed very shortly by the Ministry for the protective garment for members of crews. The memorandum sets out full details of the requirements outlined above, which are to be completed by the end of September.

The Employment Returns

IT was officially announced by the Ministry of Labour and National Service on Thursday, July 10th, that the number of men and boys registered at employment exchanges in Great Britain as wholly unemployed at June 16th was 121,562, a decrease of 20,422 as compared with May 12th. Of this total, 34,763 had been classified by interviewing panels as unsuitable for ordinary industrial employment. Those registered as on short time or otherwise temporarily suspended from work on the understanding that they were shortly to return to their former employment numbered 18,046. This was a decrease of 9738 as compared with May 12th. Those registered as unemployed casual workers (being persons who normally seek their livelihood by jobs of short duration) numbered 9803, a decrease of 2252 as compared with May 12th. The corresponding figures for women and girls at June 16th were 122,094 wholly unemployed (of whom 3975 had been classified by interviewing panels as unsuitable for normal full-time employment), 29,687 temporarily stopped, and 747 unemployed casual workers. As compared with May 12th, the numbers wholly unemployed showed a decrease of 26,234, those temporarily stopped a decrease of 8273, and unemployed casual workers a decrease of 130. The table which shows the difference between May 12th and June 16th, 1941, in the total number of unemployed on the registers for the various administrative divisions indicates that there has been a reduction in unemployment in all the divisions. The largest fall in unemployment occurred in the London division.

War Production in Northern Ireland

LAST week important changes were announced by the Ministry of Commerce in the machinery for the organisation of war production in Northern Ireland. Hitherto, there has been some confusion as to the exact relationship between the Northern Ireland Government and the various Departments of the Imperial Government concerned with war production. The Government of Northern Ireland has been responsible for questions of labour supply, transport, power, and electricity, and the whole machinery of civil government. Arrangements for war production in Northern Ireland have, however, been made directly by Departments at Westminster, and there has consequently been the necessity for constant reference to London on matters which have been within the competence of the Northern Ireland Government. The Production Executive of the War Cabinet has now decided that the Ministry of Commerce should become its agent for ensuring the due performance of the war production programme in Northern Ireland and should become the Department responsible for matters affecting the programme of war production in this area. As a consequence of that decision, it has been decided that the existing Regional Board, consisting of representatives of the various Imperial Production Departments, together with representatives of employers and trade unionists, is to be replaced by a Production Committee, which will be appointed by the Minister of Commerce, and will deal with matters affecting war production in the area. By the new arrangements it is hoped that the difficulties which were bound to arise from dual control will be removed, and that by close collaboration between the Ministry of Commerce and the Production Departments, Northern Ireland will be in a position to make, smoothly and efficiently, its maximum contribution to the war effort.

Industry and Taxation

IN the course of his chairman's speech delivered at the annual general meeting of Edgar Allen and Co., Ltd., which took place at Sheffield on Friday, July 11th, Mr. C. K. Everitt made reference to the way in which taxation is affecting the engineering industry. He said that, while affirming his conviction that the revenue necessary to finance our war effort should be derived in the main from taxation to the maximum degree possible, and accepting the general principle that undue or excessive profits resulting from the national emergency should not be privately retained, he recalled that taxation often produced unexpected and undesired consequences, and that profits as assessable to tax were not computed on a commercial basis, but according to complicated statutory rules whose principal object was the raising of revenue. He concluded from the typical figures quoted that continuance of the Excess Profits Tax at its present rate of 100 per cent., combined with the current high level of income tax, must endanger the stability and development of industry at a time when both were vitally necessary to the national welfare, since the normal and natural increment of capital available for both, arising from prudent reservation of a substantial portion of earned profits—hitherto regarded as a sound financial policy—was now made impossible by current taxation.

Industrial Expansion Risks and Inadequate Allowances

IN a further part of his speech Mr. Everitt dealt with risks in industrial expansion and said that modern methods and levels of taxation made insufficient allowances for losses which might be incurred in connection with plant installed for war purposes. The risks, he said, inherent in development and expansion in industry, especially those contingent on interruption or cessation of demand, had at all times to be weighed with care, and, without assurance of sufficient capital and of reasonable continuity of demand, no industrialist—responsible for the fortunes of his business and for the capital of others—dare undertake expansion on any but a limited scale. In times like the present those risks, and the amount of capital required for provision of increased stocks of materials, extension of credit in book debts, installation of plant and equipment—all essential and proportionate to the degree of expansion—were extended and intensified. The product had in many cases changed in character; new plant installed for purely wartime purposes would be almost certainly unemployable thereafter; stocks, increased at high price levels, were disproportionate to any foreseeable future requirements, and plant was suffering abnormal wear and tear from intensified working while normal maintenance and repairs were arrested. Present methods and levels of taxation, Mr. Everitt concluded, made insufficient allowance for those losses. He did not minimise the value of the so-called "20 per cent. concession" proposed this year, but felt that it did not go far enough. What industry needed, in his opinion, was assurance that each business should have a charge on its own "Excess Profits" sufficient to cover all losses—including wastage of fixed capital assets—incidental to their being earned, and also for the purpose of necessary expansion and development, both present and future. He was confident that, if this were given, the country would benefit both in urgently needed output and in revenue.

Lloyd's Register American Committee

AT the recent annual meeting of the American Committee of Lloyd's Register of Shipping, Mr. John D. Reilly, president of the Todd Shipyards Corporation, was elected as chairman of the Committee, in succession to Mr. L. H. Korndorff, president of the Federal Shipbuilding and Dry Dock Company, who has held that position for the last two years. In his report to the Committee Mr. William Bennett, the chief surveyor for North America, stated that his staff, which during last year has been increased from twenty-five to sixty-five, was exceptionally busy both in Canadian and American shipyards. The biggest job, he said, was the supervision of the construction of the sixty 10,000-ton cargo steamers ordered by the British Purchasing Commission, which are now being built at two new shipyards, that of the Todd-Bath Iron Shipyard Corporation, at South Portland, Maine, and the Richmond Yard of the Todd-California Shipbuilding Corporation at Richmond, California. The Committee also elected as its Vice-Chairman Mr. J. G. Johnson, vice-president of the Sinclair Oil Company. Other members of the Committee who were elected included Mr. H. Gerrish Smith, president of the National Council of American Shipbuilders; Mr. C. W. Bowring, jun., president of Bowring and Co., and a director of the British Ministry of War Transport; Mr. W. N. Westerlund, of C. D. Mallory and Associates; Mr. T. E. Buchanan, general manager of the Marine Department of the Texas Company; Mr. L. S. Kennedy, vice-president of the firm of March and McClellan, underwriters; Mr. B. K. Ludwig, president of the National Bulk Carrier Corporation; and Mr. Garcia, of Garcia and Diaz.

Mercantile Shipping Losses in June

ON Tuesday, July 15th, the Admiralty issued a statement on the mercantile shipping losses sustained by enemy action in the month of June. It is recorded that the figure is the lowest since January, but that it is still dangerously high. Fifty-two British ships, totalling 228,284 tons, nineteen Allied ships, totalling 82,727 tons, and eight neutral ships, totalling 18,285 tons, were sunk, making a grand total of seventy-nine ships of 329,296 tons. It is pointed out that although the total is substantially lower than for the month of May, it is still at the high rate of nearly 400,000,000 tons a year, and must be brought much lower. While our resources and counter-methods show continuous improvement, and there is a prospect of further reductions in sinkings, no effort, it says, must be relaxed. During the same period the Germans claimed to have sunk a total of 876,783 tons, which, it will be noted, is nearly two and a half times the real loss. It is estimated that the enemy losses of merchant shipping, by capture or sinking, for the period from June 10th to July 10th, are about 180,000, making as near as can be estimated a total for the whole war of about 3,391,000 tons. That figure, the statement says, is uncertain owing to the impossibility of ascertaining exactly the tonnage of ships which are sunk either by submarine or air attack. With the June figures the Admiralty has issued a further list of sinkings for the years of 1940 and 1941, to which have been added, we note, sixteen ships, totalling 85,919 tons. Accompanying the Admiralty statement for June is a notification that after that date it is not proposed to continue to publish the shipping losses due to enemy action at regular intervals, as by such means valuable information is given to the enemy. From time to time, however, the Admiralty will consider the publication of shipping losses as may be required.

The Concentration of Industry

IN a written answer to a question in the House of Commons on Tuesday, July 15th, Sir Andrew Duncan, the President of the Board of Trade, dealt with the invitation to industry to conclude agreements for the concentration of industry contained in a White Paper issued in March last and said that it had evoked a very satisfactory response. Altogether, he said, nearly 110,000 workers had been released or were being made available for release under arrangements now in hand in the industries concerned. About 16,500,000 square feet of factory space had been placed at the disposal of the Controller-General of Factory and Storage Premises, a considerable proportion of which would be immediately available for war production or storage dispersal purposes. The period allowed for the submission of voluntary schemes on the basis prescribed in the White Paper had now come to an end. In a number of the lesser industries the results aimed at had been substantially achieved, and gratifying progress had been made in large sections of the more important industries affected by the Limitation of Supplies Orders or by the rationing of raw materials. The Board of Trade was, Sir Andrew stated, in conjunction with other interested Departments, now hastening the completion of these measures by itself nominating nucleus firms. Regard was being had to the part which the firms were desired to play in supplying goods for Government orders, export, and home civilian trade, and also to the demands in particular localities for factory space and labour. The application of this policy of concentration to other industries than those originally specified must depend to an important extent on whether the industry was one in which there was substantial surplus capacity, and in which concentration would release a substantial amount of labour or factory space useful for war purposes. An accompanying memorandum announces that a central concentration association is to be formed, consisting of firms (machinery users or processors) who subscribe to the obligations resting on members of the association. The administration of the association will be in the hands of the Central Concentration Committee.

Historic Accidents and Disasters

No. II

(*Continued from page 20, July 11th*)

THE TAY BRIDGE—PART II

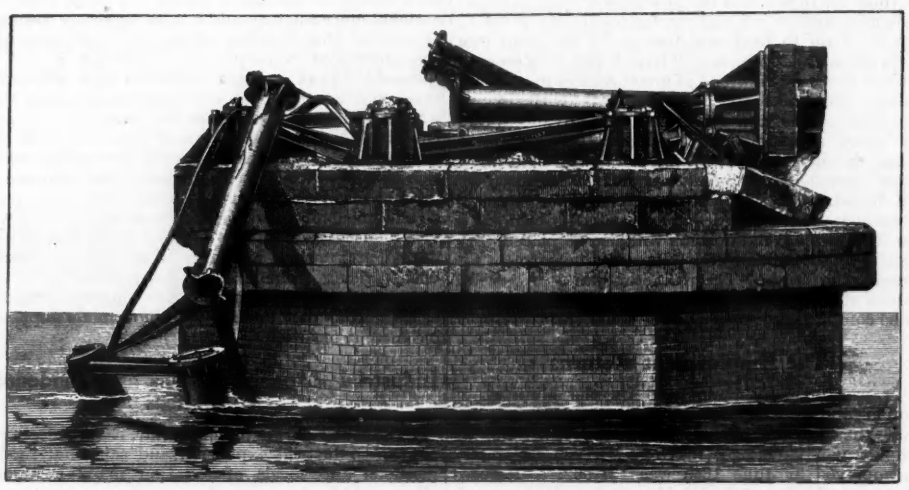
THE Court of Inquiry appointed by the Board of Trade to investigate the causes of the disaster consisted of Mr. W. H. Barlow, Col. W. Yolland and Mr. H. C. Rothery. It heard evidence first at Dundee and then in London. Sir Thomas Bouch was naturally entirely unwilling to admit that the bridge collapsed because of its defective design, while the contractors were equally unwilling to admit that the disaster was in any way contributed to by defective material or defective construction or erection. Sir Thomas, ably represented by Mr. Bidder, Q.C., sought to explain the disaster in a manner which relieved him of all responsibility for it and placed it, if anywhere, on the shoulders of the railway company. His theory was that the last carriage of the train, the second-class carriage immediately preceding the guard's van, was lifted by the force of the wind and ran some distance on one pair of wheels until it was derailed by reason of its leading corner coming into contact with the leeward girder of the bridge. Then the guard's van telescoped into it and the two vehicles expended their momentum on the lattice bars of the girder and so brought the bridge down. Evidence adduced in support of this view turned mainly on the discovery of certain marks and other damage on the remains of the second-class coach which pointed to its having come into contact with something. It was, however, clearly established that these marks were just as manifest on the windward side as on the leeward. That the second-class carriage and the guard's van were broken up to a much greater extent than the other carriages—another point adduced in support of Sir Thomas Bouch's theory—was fully accounted for by the fact that they were light and old vehicles and of much weaker construction than the rest of the train. Cross-examined, Sir Thomas was forced to admit that if his theory were correct all the thirteen spans tumbled down one after another because two of the tie bars in one of the lattice girders were severed by the impact of the second-class carriage against them. It is not surprising that following this admission Sir Thomas' theory was modified by Dr. Pole, his confidential adviser. The supposition that the second-class carriage and the guard's van were blown off the rails and flung against the leeward girder was adhered to, but the suggestion that the impact wrecked the girder was abandoned. Instead, it was argued that the *vis viva* of the derailed vehicles was expended against the girder in a lateral direction and that the shock of the impact was transmitted down to the cast iron piers, which thereupon failed under the combined load of the shock and the prevailing wind pressure.

The Court could find no reason to accept either Sir Thomas' theory or Dr. Pole's modification of it. If the two vehicles at the rear had left the rails the engine driver could hardly have failed to notice the fact and to have taken action to stop the train. After the disaster the throttle valve was found full open and the link motion in forward gear. Again, the evidence of eye-witnesses and deductions drawn from an examination of the salvaged girders preponderated in favour of the supposition that the bridge collapsed in three sections, the northern going first, the middle second and the southern, with the train on it, last.

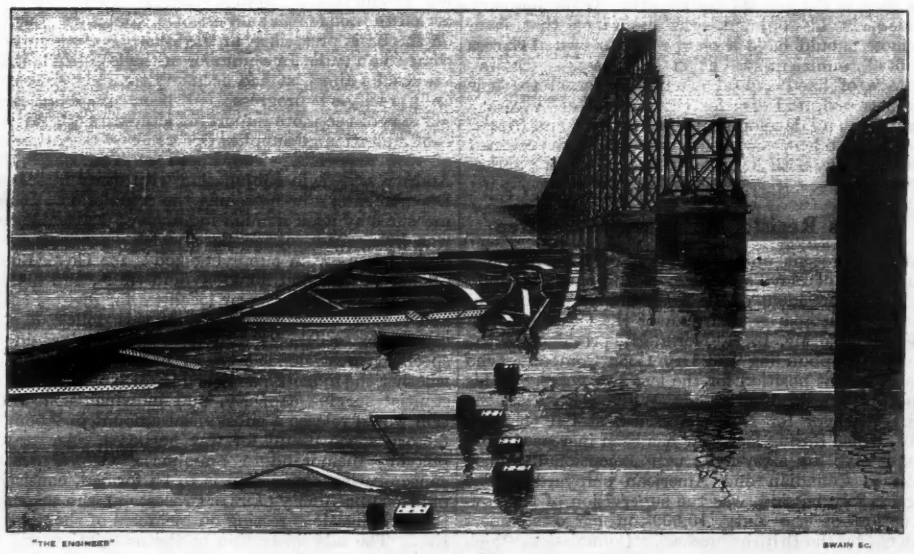
The railway company expressed the view that the disaster was to be attributed solely to the "overpowering violence of the wind." The suggestion behind this opinion seems to have been that the gale on the night of December 28th was of such phenomenal and unprecedented intensity that no structure such as the Tay bridge, however well designed and built, could have survived it. The storm on the night of the disaster was certainly a very violent one, but it was not of altogether exceptional violence. A Dundee meteorologist testified before the Court that during the preceding fourteen years he could remember about four storms of equal intensity. Again, the commander of the training ship "Mars," which was lying about three-quarters of a mile below the bridge at the time of its collapse, stated that he had experienced more severe storms even in this country and that in the West Indies and the China Seas he had encountered gales "very much more violent" than that which raged in the estuary of the Tay on the night of the disaster. Clearly then the Court could not subscribe to the view that the disaster was to be attributed solely to the cataclysmic, wholly unforeseeable violence of the wind.

The Court found that the bridge was "badly designed, badly constructed and badly maintained and that its downfall was due to inherent defects in the structure which must sooner or later have brought it down." It held Sir Thomas Bouch entirely to blame for the faults in the design and principally to blame for the faults of construction and maintenance. It also censured the constructors, Hopkins, Gilkes and Co., for permitting grave and perilous irregularities to occur at the Wormit foundry, which had been established by them on the banks of the Tay and at which the columns and other cast iron parts of the bridge were manufactured.

It is unnecessary for us to dwell upon the defects in the design of the bridge. They should be self-evident even to those of our readers who are not directly connected with bridge building as now practised. It is sufficient to say that the girders themselves escaped criticism of a serious kind, the only adverse comment passed on them being that their lattice work was perhaps somewhat too open. The defects of the design lay chiefly in the piers. The structure, after it fell, was described as a bridge on stilts and weak stilts at that. Even if the material of the columns and the column bracing had been sound and soundly assembled, the piers would have lacked the reserve of strength and stability which modern practice would regard as the minimum necessary for a bridge at a site notorious for the violence of its storms.



PIER NO. 9 FROM THE SOUTH



FALLEN GIRDER AT LOW WATER

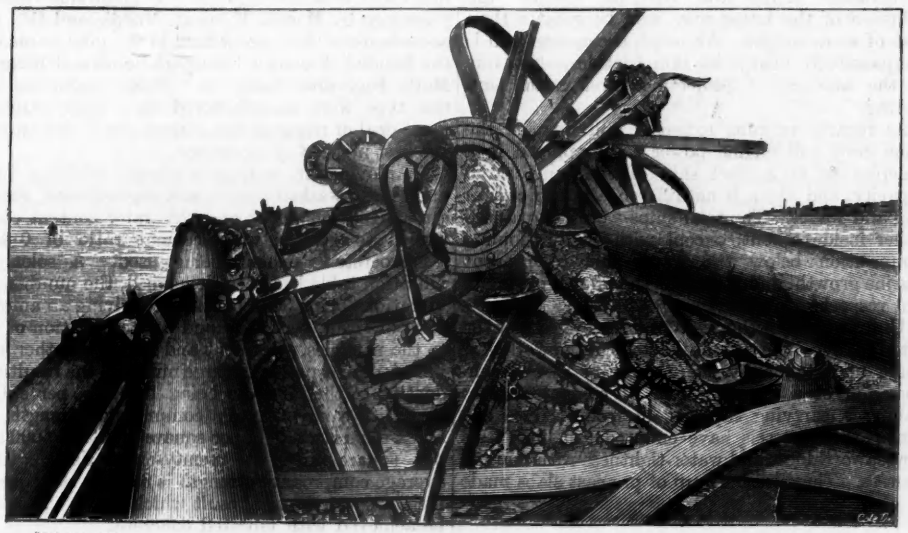
To the defects of the design must be added the defects of construction arising mainly from the "grave irregularities" at the Wormit foundry. Some of these irregularities were of a personal kind. Others were of a material or technical nature. Of the personal irregularities we need say little if, for no other reason, because the Court failed to succeed in fully probing them. It should, however, be said that the evidence of witnesses called before the Court revealed an amazing lack of supervision over the working of the foundry on the part of Sir Thomas Bouch and on that of Hopkins, Gilkes and Co. and of those nominally in charge of the foundry on the contractors' behalf. It is a fact that of those who could or should have exercised authority at the foundry, several never seem even to have visited it—one of them being actually a paralytic—while others had too much work to do elsewhere to pay any close attention to the foundry. The general superintendence of the foundry was in the hands of a gentleman who confessed to the Court that he had no special knowledge of iron-work. The contractors' inspector was a Dutch engineer, who previously had had no practical experience in a foundry and who in the Court's words was "unfit" for and "incapable" of detecting defects in the castings. In these circumstances it is not surprising to read that effective control over the working of the foundry and the detection and rejection of bad castings was concentrated in the hands of the foreman moulder and that this man was in a position to do pretty well as he wished or, if reproved by those over him, to persuade them to accept his views. The story of the Tay bridge disaster contains no details more at variance with what we would now call sound practice than those connected with the management of the Wormit foundry.

It was in that foundry just as much as in Sir Thomas Bouch's drawing-office that the true origins of the disaster were to be found. Operated, as it was, it was almost inevitable that the work it produced should be defective. Defective the castings were in almost every way in which a

casting can be defective. The iron employed was mostly from the Cleveland district. It was considerably more sluggish than the metal to which the Scots moulders were accustomed. They expressed a dislike to it and urged that a sufficient quantity of Scottish scrap should be mixed with it. This suggestion was not adopted. The sluggishness of the metal was such that frequently it became chilled while passing round the core of the columns, with the result that the two edges failed to unite. The metal, too, would on occasion displace the sand of the mould and the sand mixing with the metal would float to the surface and form an unsound place in the column. These unsound places were occasionally filled in with lead or with a mixture of resin and iron filings. Frequently the core would shift and the column would emerge from the mould with very uneven wall thicknesses. Specimens were laid before the Court in which the wall thickness on one side was as little as $\frac{5}{8}$in., while on the other side it would be as much as $1\frac{3}{8}$in. Some of these defective columns were detected and broken up, but as the only means employed to detect unevenness in the wall thickness was the tapping of the columns with a hammer there could be no assurance that all those used in the bridge were satisfactory. Indeed, after the disaster inspection showed that some of the column sections used in the bridge suffered markedly from the defect of uneven wall thickness.

Of all the defects in the design of the piers, none will strike the modern engineer more forcibly than the manner in which the bracing was attached to the columns, namely, by means of bolts passing through lugs cast on the sides of the column sections. On these lugs everything, it may be said, depended, for if they gave way the bracing would cease to exercise its function and any sideways thrust on the bridge caused by wind pressure would be resisted solely by the stiffness of the cast iron columns. It will be noted that the diagonal bracing was designed to withstand tension only, and therefore Sir Thomas Bouch may justifiably be said to have placed the entire safety of his structure at the mercy of the ability of the cast iron lugs to resist *tension*. It might have been excusable—in those days at least—to have done so if the bolts uniting the bracing to the lugs had been carefully fitted in their holes. As it was the holes were cast in the lugs and were not subsequently machined or finished by hand in any way. The bolts were $1\frac{1}{4}$in. in diameter. To ensure that they would fit without trouble the holes in the lugs were made $1\frac{1}{2}$in. in diameter. Further, to facilitate the casting of the holes they were formed with a distinct taper. Thus not only did the method of connecting the bracing to the columns provide the possibility of relative slip; the arrangement was such that the load transmitted through the lugs was taken, not by their full width, but by a narrow strip of the metal composing them. The Court took a very grave view of this defect and even Sir Thomas Bouch admitted that, had he known about it, he would have taken steps to avoid it. The specification, Sir Thomas added, stated that the holes in the flanges of the column sections were to be drilled, but it said nothing about the holes in the lugs, although, he contended, it was a fair inference that they, too, were meant to be drilled.

These revelations must strike us to-day as truly appalling. One other fact, however, has still to be mentioned. The sluggishness of the iron used at the Wormit foundry was such that frequently the column sections emerged from the moulds with the lugs missing. In such cases it was the practice of the foreman to "burn-on" the omitted lugs. At one time the manager of the foundry seems to have felt some uneasiness about this procedure, but the foreman succeeded in persuading him that it was in all respects satisfactory.



"THE ENGINEER" SWAIN SC.

PIER NO. 11 FROM THE WEST

It is still sometimes asserted that the cause which led to the collapse of the Tay bridge was and always will remain a mystery. The statement is true only in the sense that it is impossible to say which detail of the bridge was the first to give way on the night of December 28th, 1879. With so many parts badly designed from the start and others badly made and with the whole bridge strained and distorted by previous storms and by the running of trains at high speed across it, it seems almost cynical to discuss which detail failed first. Had the bridge not collapsed when it did and in the way it did it would certainly have fallen soon afterwards in some other way. There is no mystery about its failure in the sense that it is impossible to find a reason why it should have failed. There are a dozen reasons for wondering why it managed to exist in service for as long as it did—something over a year from the date of its opening.

In recalling the story of the Tay bridge we feel to-day less shocked by the temerity, carelessness and—in considerable measure—lack of technical knowledge displayed by those prominently associated with its design and construction; more do we feel admiration for those engineers who with the Tay bridge disaster still poignant in their minds set out within a few years to build another great bridge on an entirely new principle. Whatever the Americans may say regarding its supermassiveness, the Forth bridge to-day stands as a memorial, not only to the high technical ability, but to the undaunted courage of Sir John Fowler, Sir Benjamin Baker and Sir William Arrol.

(To be continued)

Concrete Ships

By ROLT HAMMOND, A.C.G.I., Assoc. M. Inst. C.E.

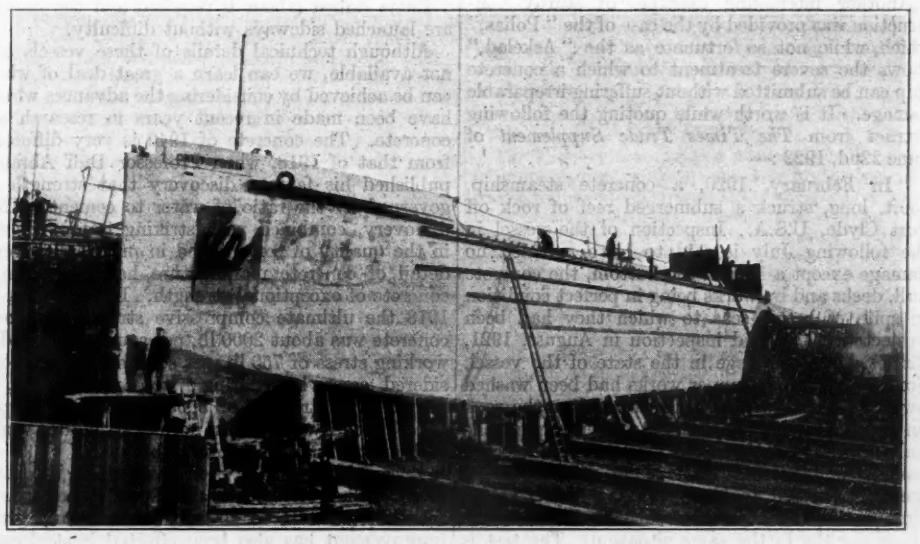
PRESENT events are showing us all too clearly that the vital Battle of the Atlantic will only be won by a supreme effort in every direction, not least in the rapid replacement of lost tonnage; in this latter respect there is no doubt that the concrete ship will play an important part.

During the last war remarkable strides were made in developing this type of vessel, instanced by the fact that during the war period a total of 150,000 deadweight tons of concrete shipping was completed in Norway, Great Britain, the United States, France, Italy and in other parts of the world. Mr. N. K. Fougner will go down to history as the pioneer of the concrete ship, having been responsible for the completion of some thirty vessels. The first concrete ship to be laid down was the Norwegian "Namsenfjord," launched in 1917, which had a deadweight cargo capacity of 200 tons. On her official trials she showed remarkable freedom from vibration and steady steering in a south-westerly gale against heavy seas; this vessel was followed by the further Norwegian examples of the "Stier" and "Patent," each of 600 tons, and then by the "Askelad" and "Concrete" of 1000 tons.

On her official trials the M.S. "Stier" ran into such rough weather that other ships of similar tonnage refused to put to sea. The Norwegian Government Inspector on board reported that the pumps were not used and that the hull remained perfectly tight. She was eventually sold to Greece, trading in the Mediterranean and Red Sea under the name of "Aliakmon." Similar weather conditions were encountered by the "Askelad" during her trials in November, 1917; in December she sailed from Christiana to Rouen, through heavy seas in the teeth of a westerly gale. Her captain bore witness to the fact that she was thoroughly seaworthy; she was later engaged in trading to Norwegian, Swedish, Dutch and British harbours. She also made some voyages to the Baltic, where ice proved troublesome.

It is interesting to note in passing that the "Askelad" was claimed to be the cheapest ship of her size to be built in Norway between the years 1917 and 1920.

During the same period the British Ministry of Shipping embarked on a large programme of construction, embodying about 150,000 deadweight tons; only about fifty seagoing lighters and



CONCRETE STEAM TUG "CRETEFARM" ON STOCKS

twelve steam tugs were completed. Nevertheless, even to-day we can learn valuable lessons about the capabilities of these vessels from the experience of those days. Two outstanding examples of British-built ships provide evidence of behaviour under severe conditions. These vessels were the steam tugs "Creteboom" and "Cretestem," built in 1919 and examined in 1934, after more than fifteen years' service afloat.

The "Creteboom" sailed for some years in the Baltic, and on one occasion she was icebound for several days; after a special survey made by Lloyds on her return to this country certain restrictions on her trading movements were removed, and she afterwards traded in Portuguese waters. In 1926 she towed the Southern Railway Company's floating dock from the Tyne to Southampton.

"Cretestem" was also frozen up in the Baltic, and on one occasion she came into head-on collision with a steamer. For several years these two ships were laid up in the Tyne during the shipping depression; although dirty and unkempt looking, their structures were perfectly sound. Expansion, due to the heat from the boilers, had formed hair cracks in the decks, none of which were of importance. Below decks neither weeping nor condensation were evident; the cabin walls, although dirty, only required a coat of paint. The bilges were also perfectly dry.

In the United States, where astonishing feats of rapid shipbuilding were accomplished by the United States Shipping Board, the concrete ship was developed to a surprising extent. Four cargo vessels of from 2500 to 3000 tons deadweight and eight oil tankers, each of 6500 tons, were completed before the Armistice. The most outstanding example was the "Faith," a vessel of 5000 tons, launched at Redwood, California, in March, 1918. She made voyages to Vancouver, Honolulu and Chile, reaching New York harbour *viâ* Panama in November, 1918; in the spring of 1919 she arrived in London, the first concrete ship to cross the Atlantic.

Cost of repair is always a matter of vital importance, and here the concrete ship shows to advantage. For example, on January 16th, 1919, the motorship "Askelad," during her passage through the English Channel under heavy weather, was driven ashore in the estuary of the River Somme; she bumped so violently on the bottom that footing could not be kept on the bridge. At low tide she was left high and dry and was abandoned by her crew, who believed that she would probably break up with the next tide. A few days later, however, it was found that the hull was quite sound, and she was refloated on the spring tide on February 1st. Ten days later she arrived in London, where a preliminary survey indicated that she was sufficiently seaworthy to go to Grimsby; she docked there on March 12th.

It is interesting to note that no repairs were needed on the concrete hull, beyond the application of a few patches of cement mortar by the crew. After a survey at Grimsby she was again put into service and was not dry-docked until the following September; minor repairs were done to deck fittings, and the cement finish on the deck was repaired in a few places. The total cost of repairing the hull of the "Askelad" after grounding on the French coast did not exceed £25; some years later the ship was engaged in the Baltic, North Sea and Channel trade.

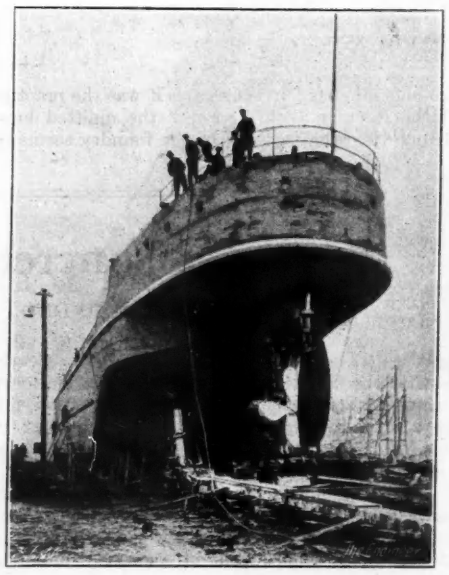
Another interesting example of sturdy construction was provided by the case of the "Polias," which, while not so fortunate as the "Askelad," shows the severe treatment to which a concrete ship can be submitted without suffering irreparable damage. It is worth while quoting the following extract from *The Times Trade Supplement* of June 22nd, 1922:—

"In February, 1920, a concrete steamship, 250ft. long, struck a submerged reef of rock off Port Clyde, U.S.A. Inspection of the vessel in the following July is said to have revealed no damage except a hole in the bottom, the concrete hull, decks and bulwarks being in perfect condition in spite of heavy seas to which they had been subjected. A second inspection in August, 1921, disclosed little damage in the state of the vessel. Some of the timber upper works had been washed away, but the hull appeared as solid as the rock on which it rested. According to recent reports the hull is still intact after exposure to the sea for over twenty-eight months. The chief of the salvage crew is reported to have stated that a steel or timber vessel would not have survived for more than three months in the same situation. The test is one showing very clearly the high resistance of reinforced concrete to exceptionally severe shocks and stresses."

Experience has shown that the speed of a concrete ship is similar to that of a steel ship of the same deadweight carrying capacity and engine power, making due allowance for such factors as under-water shape and external finish; the influence of the latter may well be greater than that of mere weight. Although a concrete hull is comparatively heavy, its skin friction is low, due to the absence of projecting rivet heads and plating.

As regards running expenses and upkeep, the same crew and engine power are employed in a concrete as in a steel ship of the same cargo capacity, and there is no difference in the cost of fuel and wages. The trial ships were not painted either inside or out, except with an anti-fouling composition below the water line to prevent marine growth, and there was therefore a saving in this respect.

Unfortunately, the veil of secrecy cannot be lifted to reveal the technical details of the work now being undertaken by the Admiralty in the construction of a large number of concrete barges having a carrying capacity of from 180 to 200 tons; these vessels have endured gruelling tests for seaworthiness and water-tightness with marked success. They are built up of pre-cast slabs made



STERN OF S.S. "ARMISTICE"

in a yard some distance from the slipways, the first operation consisting of laying the bottoms; these are formed of the slabs arranged in regular fashion and subsequently connected together by means of narrow concrete stiffening members cast in place. Slabs for walls and decks are joined in a similar manner, and in all cases the steel reinforcement projects beyond the edge of the slabs, so as to bond the slabs together like a monolith. For example, the sides of the barge consist of concrete slabs, which are connected at their lower edges to the bottom of the barge and at their vertical edges to one another.

Little skilled labour is required and the barges are launched sideways without difficulty.

Although technical details of these vessels are not available, we can learn a great deal of what can be achieved by considering the advances which have been made in recent years in research on concrete. The concrete of 1940 is very different from that of 1918, when Professor Duff Abrams published his famous discovery that strength is governed by the ratio of water to cement. This discovery, combined with striking improvements in the quality of cement and in practically every detail of concrete manufacture, has resulted in a concrete of exceptional strength. For example, in 1918 the ultimate compressive strength of good concrete was about 2000 lb. per square inch and a working stress of 750 lb. per square inch was considered somewhat daring; to-day, however, a compressive strength of 5000 lb. to 6000 lb. per square inch is expected in normal structural work, and greater strength is often obtained.

Recent bridges have been designed on the basis of a working stress of nearly 2000 lb. per square inch and 1200 lb. to 1500 lb. is common; great improvement has also been effected in steel reinforcement, a tensile stress of 27,000 lb. per square inch being commonly used instead of the 16,000 lb. used in designing the concrete ships of 1918.

Some indication of what may be achieved by modern methods is instanced by the recent developments of pre-cast concrete segments for lining the tube tunnels in London. An experimental reinforced concrete segment was made some three years ago by Messrs. Kinnear, Moodie and Co., in accordance with a patent held in the joint name of the London Passenger Transport Board and Messrs. Mott, Hay and Anderson. Before segments of this type were manufactured on a large scale a great deal of research was carried out to determine the best method of procedure.

Employing an aggregate graded between $\frac{3}{8}$in. and $\frac{1}{8}$in. of washed shingle and washed sand, these are gauged by weight and the water content controlled to give a water/cement ratio of 0·42, "Ferrocrete" cement being used. A solenoid vibration table has been developed, the number of vibrations being 3000 per minute, giving an amplitude of $^1/_{64}$in. vertically and an acceleration of $4g$ to the particles. Segment and mould together are vibrated for a period of three minutes, the resulting density of the concrete being 150·4 lb. per cubic foot with a zero slump; compressive strength at seven days is 4000 lb. per square inch and 6000 lb. per square inch at twenty-eight days. The average compressive strength is 6500 lb. per square inch at seven days, a result which shows what can be achieved with vibrated concrete.

Future research in concrete will undoubtedly develop its possibilities even further, and the concrete of 1950 will be as far in advance of the present-day product as that material exceeds the 1918 concrete. Although great progress has been made in the production of light-weight aggregates, this lightness has only been achieved at the expense of strength, and so far no such material has been used for structural work. If these could be successfully developed, however, they would be of great benefit to the shipbuilder, who is very fortunate in being unhampered by many of the limitations which exist in building and constructional work. At present, light-weight construction must be looked for in improved quality of normal concrete and consequent reduction in thickness, rather than in the use of special aggregates.

The two illustrations give some idea of the simple design to which a concrete ship is built; it will be noticed that both examples are of the hard chine type and that there appears to have been no difficulty in forming the stern of the "Armistice." The author believes that the concrete ship has a great future before it, and that we shall probably gain a great deal of new information about it as a result of this war.

Sixty Years Ago

ELECTRIC LIGHTING IN COLLIERIES

IN our issue of July 15th, 1881, we described the attempts then being made to introduce the use of electric lighting into collieries. It was clearly recognised from the first that electric lights in a gassy mine might constitute a source of danger. One plan seriously proposed in the United States consisted of providing a brilliant electric light at the pit mouth and of directing and dividing the light to the points underground at which it was required by means of lenses and tubes. This plan, we thought, might be practicable on a small scale, but on a large scale the enormous cost and the loss of light resulting from the imperfection of the lenses would probably render it useless. The success of Swan's incandescent lamp for lighting the interiors of buildings had suggested its use for mining operations. Mr. R. E. Crompton, we recorded, had, in conjunction with Mr. Swan and others, for some time been experimenting with a view to such an application. Under the auspices of the Mines Accidents Commissioners experiments had been carried out at the Pleasley collieries near Mansfield. Two types of lamp had been tried, an ordinary Swan lamp, fitted with wooden sconces, for the main roads, gates, &c., and a lamp of special construction for use by the miners. These special lamps had a second globe surrounding the globe proper. The air between the two globes was sufficient to ensure the instantaneous combustion of the carbon filament should the inner globe be broken. Great progress was undoubtedly being made and we trusted that before long the use of electric lighting in collieries would be developed to an extent that would place the miner in a far better position as regarded safety than he was in at present.

THE HINCHLEY LECTURE.—The Hinchley Memorial Lecture to the Institution of Chemical Engineers will, this year, be delivered by Sir Richard Gregory, F.R.S., and will be entitled "Scientific Knowledge and Action." The time and place are not yet announced.

House of Commons Debate on Supply

ON Wednesday and Thursday, July 9th and 10th, the House of Commons, in Committee, debated Production. On the first day the Parliamentary Secretary to the Ministry of Supply (Mr. Harold Macmillan) replied for the Government. Below we give excerpts from his speech.

GUNS AND TANKS

The first quarter of this year showed an increase in the production of both guns and tanks of more than 50 per cent. over the last quarter of 1940, and the second quarter of 1941 shows an increase of more than 100 per cent. over the last quarter of 1940.

MACHINE TOOLS

The whole problem of the supply of aeroplanes, tanks, guns, munitions of war, ships and transport centres round the provision of machine tools, the equipment used on or with the machine tools, and the provision and training of the labour to use them. We have had to supply all Departments—for this is a central service—with a great complexity of types to the number of many thousands a month tooled to meet the varying types of manufacture. There were two sources from which machine tools and their equipment could be obtained—our normal machine tool factories at home and importation from America. At the outbreak of war the machine tool industry was already working at high pressure, and immediately after the war it was decided to extend it still further. We had to balance the requirements of industry with the need of providing plant to bring about an expansion of the country's capacity to produce machine tools, and to-day the output of the machine tool industry is six times that of the normal peacetime level.

As important as the machine tools is the equipment, and at the same time we have had to make provision and have made provision for the supplying of jigs, gauges, and small tools. We have enormously increased the capacity of the firms that specialise in that work, and at the same time we have enormously increased the capacity of the engineering firms themselves to make this equipment in their own tool-rooms. There has been a parallel expansion in the tool-rooms of the engineering firms, and in the new works especially delegated for the sole production of machine tool equipment. In spite of all these efforts, we have, partly because the total volume was not sufficient and partly because of the character of the specialised machines which could only be imported, had to rely upon our American friends. All through these months we have worked closely hand in hand with the American Government. We have had the most understanding assistance from the American authorities, including the Army and Navy. We are now perhaps in a position to reciprocate what they have done for us, because our demands are becoming smaller. There are certain specialised machines we shall still make, but we shall be able to make smaller demands on their production, thus releasing it for a production which we hope will be to our ultimate benefit. It is perhaps a picture of the degree to which the machine tool problem has been tackled that we have already been able to swing over more than half our machine tool producing capacity from the production of tools proper to the production of jigs, gauges, and equipment. As the war goes on, we shall reduce the production of machinery and increase the capacity for producing the equipment which is always needed and without which machine tools are of no value to the engineer.

ABSENTEEISM AND MANAGEMENT

Exaggerated statements about wilful absenteeism on the one side and negligence or inability to promote the production effort on the other can do nothing but harm. Let management and labour continue as they are doing in ninety-nine cases out of one hundred and concentrate upon the enormous task which lies before them. To the extent that there are complaints and criticism, which I certainly do not resent, let them be put upon the broad, hardened backs of His Majesty's Government. I am sure that that agreeable task will be much less dangerous to production and may be of greater value in the long run. I would only say that generalised criticism is not much help to His Majesty's Government. If we can get criticism directed to a special service or establishment, it makes it easier to institute an inquiry.

ABSORPTION OF LABOUR

I admit at once that there have been mistakes, difficulties—follies, if you like—but who has ever attempted to build up an organisation of this kind on so great a scale in so short a time and has avoided all mistakes?

In ordinary private enterprise it is regarded as quite a good achievement to have built up over a long period of years a business employing 5000, 10,000, or 20,000 men, and after long experiments in management, in selecting the right people and all the rest of it. We have had to do this work quickly. We must recognise also the difficulties which confront us. The recruitment for the factories depends not merely on the amount of labour available, but on the power of any individual factory to take that labour as the factory comes into production. It cannot take to-day the whole of the labour which will be its final complement. The labour must come in at a rate at which it can be trained and got into work. The Ministry of Labour, through a special scheme which was launched for us during the last three months, has, broadly speaking, with possibly one exception, been able to provide us with labour at a rate appropriate to our power to absorb it. In the six months between January and June we have more than doubled the labour force employed in the ordnance factories—mechanical, filling, and explosive. The Committee would not expect me to give in public the total of those employed.

ACCOMMODATION FOR LABOUR

One of the chief contributions which my right hon. Friend who is now the President of the Board of Trade was able to make in his time was to put all the filling factories on to a three eight-hour-shift basis. Already we have all the explosive factories upon a three eight-hour-shift basis, but we have not been able to change the mechanical factories on to that basis, although we are hoping for and contemplating such a change. With the help of my hon. Friend the Minister for Works and Buildings and my right hon. Friend the Minister of Labour, who is going to provide the labour, we hope to plan a great scheme of hostels and married quarters accommodation, which we must have before the winter sets in if we are to keep our factories properly employed and our people happy. We hope to have accommodation for some 60,000 men and women in our hostels and to provide accommodation for 7000 in married quarters. Rather than waste time trying to build up a new organisation within the Ministry, we have entrusted the management of these hostels to organised agencies which are well acquainted with that art, and the Y.M.C.A., the Y.W.C.A., the Holiday Fellowship, the Co-operative Holiday Association, and the Workers' Travel Association, will on our behalf and as agents undertake the actual management of these hostels.

Then we come to the problems, some of which were touched on by my hon. Friend the Member for Caerphilly, in labour management itself, the avoiding of the friction and mistakes which must sometimes occur, but ought to be reduced to the minimum. We have felt that the technical tasks entrusted to the Director-General of Ordnance Factories made it impossible for him or his technical staff to undertake this work themselves, and we have therefore appointed for this work an officer, and under him a number of superintendent labour management officers. I prefer the phrase "labour management" to the word "welfare," with its somewhat restricted and patronising appeal. I mean labour management in the broad sense in which it has been practised in recent years by all the most progressive companies. We have been fortunate in obtaining for these posts men and women who have had experience in large industries and who have been lent to us for the purpose.

TRANSPORT

Finally, we have tried to grapple with what was last winter one of the worst problems from the labour point of view, the transport problem. Whether these new factories were well sited or badly sited is not now worth arguing. They are built. With one or two parts of the country we still have some difficulty, but it is nothing to what it was. We are convinced that we are on top of the difficulty and can overcome it. We have built up a system of internal transport in the larger factories which will very much relieve the worker, from the outer platform where he arrives to the place where he actually works. This service is available not only to the Ordnance factories, but to any factories that ask for our help. Where a factory is working with as many as 5000 people we station a permanent officer to look after transport problems.

FULL EMPLOYMENT OF FACTORIES

Are we satisfied with the use of the second shift and the use of our machine tools? Are we getting the full amount out of the existing plant? Those questions have been in everybody's mind, and we have asked them of ourselves and tried to improve all the time. Of course, we are not satisfied, but we must not put impossible targets in front of ourselves. Double shifts for the whole engineering industry would be an impossible target, because they would take a figure of additional employment quite outside what we should be likely to achieve.

There is very little treble-shift work, except in those types of production for which it is most suitable. Filling factories are not mechanical engineering plants. It would be quite impossible to fill such a demand immediately. The most important thing is to concentrate upon the parts of the programme where it is absolutely vital to push forward at the greatest speed. It is very dangerous to use the figure of employment on the second shift in order to compare it with the figure of employment on the day shift. There are many men, such as maintenance men, who are employed during the day and who would not normally be employed at night, even if the second shifts were working. The production factor is the important figure. The amount of skilled labour in the country cannot rapidly be increased. It is almost fixed, and the problem of bringing unskilled labour into the industry depends upon two main factors.

The first of these factors is the degree to which the piece of work in question has been designed from the start as a mass production job. In the newer factories, set up when the present size and kind of Army was contemplated, that has been done. These factories were designed and organised so that the work could be done by unskilled people and as a mass production job, but this is not true of some of the older works which were not so designed. The second factor is the degree to which we can improve the actual utilisation of skilled men. You can employ unskilled and semi-skilled people only under the leadership of the skilled. The problem of getting a better use of unskilled and semi-skilled labour lies in more skilful use of the skilled men. Some firms have been pioneers in that respect. Their proportion of skilled men to semi-skilled is a very small one, and they have done very good work. Others have been laggard. We have to put the maximum support we can in the production Ministries and the Ministry of labour, and the maximum pressure upon our contractors, to go on with this system of reducing the ratio of skilled men in order to make the use of unskilled labour available and attract the great army of the unskilled and the semi-skilled, who can be employed only under the guardianship of the skilled men.

CONTINUITY OF ORDERS

I have dealt with many of the points that have been raised, and now I want to say a word on the very important point of continuity of orders. The instructions to proceed are regarded as the legally binding contract, and the elaborate contract, with its phraseology, so beloved of lawyers, comes along later. Nobody takes much notice of that part of the process. It is a well-known practice to operate upon the instructions to proceed. Changes in design and in the service required are responsible largely for the lack of continuity of orders. We are producing for the purpose of making the kind of weapon we want, and not merely to get a nice flow of production. We can do far better than we have done. We are always pressing our Departments to adopt the principle that where there is a known job there should be continuity of order, or, what is better still, an order to produce at a certain rate till further orders. If we are to keep the high quality of design by which alone we can make up for our numerical inferiority, there must be changes and improvements, which may have the effect of temporarily interrupting the flow of production.

The difficulty in some cases is that of purchasing far enough ahead. It is not always possible to say that the exact amount of raw material will be in the right place every day. During peacetime we do not operate within that narrow margin. Great industries invest large sums of money in stocks to ensure a flow of production, even when there is no black-out, no blitz, and no interference to the transport. We find it more difficult to buy our stocks to continue the flow of production rather than to rely upon buying from hand to mouth. In wartime the raw material is used right up to the hilt, and we work on very narrow margins. The men should be told. They should be given an opportunity to understand that we are bound to get temporary breaks. I will summarise it in this way: The flow of production must occasionally be interrupted. It is the almost inevitable result of the urge to produce more. We have to smash problems, but we also create them; it is very easy to obtain a perfectly balanced production at a very low level—complete balance is obtained at zero, and, if I may say so, the most perfect balance of all is death.

NEW INVENTIONS

The Ministry is sometimes censured for being slow in adopting new processes and new inventions. The course we have to steer on the question of new inventions is not an easy one. Behind the inventor there frequently lurks a company promoter; indeed, sometimes the two figures are combined in the same man. We have to be neither too rigid nor too elastic. We do not want to miss a good thing, but we do not want to be had for "mugs." We have to remember that any process which is accepted and approved by the Ministry, if it is in the hands of the wrong kind of people, may easily be used for the purpose of using our hall-mark to help a satisfactory flotation in New York. If anyone is really dissatisfied with the important work of scientific invention and discovery, although I may not refer to it in detail in open session, I suggest that he should put his mind to the question of how rapidly the means were found and brought into production for dealing with some of the lurking dangers which came with the blitz last autumn. Inventions were found and put into production by the skill of our scientific investigators.

And in many cases I regret to say their lives were lost in the work.

TANKS

My hon. Friend (Mr. Garro Jones) who opened the debate made some references to the organisation of the Ministry, and I think that quite by mistake he rather unnecessarily painted a picture of great confusion. The organisation of the Ministry, so far as tank production is concerned, is not at all the concern of the Director of Programmes. The "Director of Programmes" is a pompous way of describing a statistical body which serves the Minister by telling him what the programmes are, what he is going to do, and what is going on. The actual tank programme, as is the production of weapons, is under a separate heading. Sir James Lithgow is Controller-General of Mechanical Equipment. Mr. Burton is in charge of all the production side, and Mr. James Weir is in charge of all designs and development. The Tank Board are advisory and not executive. We are now trying to make tanks of very clearly defined and settled designs. I think the best comparison would be to compare them with ships, and say that we are now manufacturing two types of battle-cruiser, two types of cruiser, and one dreadnought, and that is all. I think it would be quite a good analogy to say that they are for the purposes indicated by these descriptions of ships. With regard to our orders in the United States, we are relying upon one type and one type only, which is in process of production.

MINISTRY OF MUNITIONS

The movement towards a centralised machine of government is going on all the time, and has gone further than most people recognise. There are three methods by which we have been, in fact, creating a Ministry of Munitions all the time. I would ask the Committee to allow me to give some details, dull but important. First, by central purchase of stores by one Department on behalf of all. It is not generally recognised how far that process has gone. The responsibility of the Ministry of Supply goes far beyond responsibility for the Army. We manufacture a large proportion of naval guns, and some anti-aircraft guns and spare barrels for the Navy, rifles and revolvers for the three Services, all automatic rifles, and, with a few exceptions, all small arms ammunition for all the three Services. We are responsible for the filling of all ammunition and bombs, all high-explosive bombs for the Air Force, explosives of all propellants, and all the wheeled vehicles for all Service and civil needs, including, under arrangements recently made, spare parts for vehicles already in private hands. Under mutually agreed arrangements, which have gradually been built up, we have undertaken on behalf of the Air Force and the Army and the Navy the purchase of all the woollen fabrics, cotton fabrics, boots, shoes, underwear, hand tools, cordage, and many general stores. In addition, we are buying for the Air Force their uniforms, hats, clothing, medical and surgical supplies, and camp equipment. We supply steel helmets for all Services, civilian as well as the fighting Services, and have made steady progress towards unified buying. On the whole, there is one Department making the purchase of goods on behalf of the three Services. We have purposely gone at a steady rate in order not to put too heavy a strain on the administrative machine which had to undertake this enormous task.

The second method is that by which, although contracts are still in the name of the three Service Departments, the planning of the job is done by one Ministry on behalf of all—what I would call a centrally controlled plan of production. Under that method, the Ministry of Supply has undertaken responsibility for wheeled vehicles, cranes, static internal combustion engines, and pumps. The Admiralty has undertaken chain cables. The process is continually being studied by the Committee of the Production Executive, over which I preside, and the list of products so treated is growing. Whenever we find an industry overloaded, we call the Departments together, and arrange that one of them, usually the greatest user, shall undertake planned buying on behalf of all. One of the most interesting developments in this direction has recently taken place in respect of automatic rifles and guns, whether they are made for the Air Force, for the Navy, or for the Army. Twenty different types of rifles, revolvers, and automatic guns of all designs are now under a single specialised control. The Hon. Member for Edgbaston (Sir P. Bennett) is the chairman of the Board which deals with this matter. All those guns to which my hon. and gallant Friend the Member for Hythe (Lieut. Brabner) referred come under that Board, which is a very interesting experiment in co-ordination, since it consists of the leading manufacturers under an independent Chairman. The contractors represented include the Director-General of Ordnance Factories. The Departments are also represented. The idea is that the buying should be done for all those classes of weapons as a co-operative enterprise, so avoiding some of those difficulties which have arisen through each Department acting separately.

I have described the first method, which is that of central purchase, and the second method, which is that of co-ordinated planned buying. Thirdly, there is in the case of raw materials of all kinds a system of allocation by a Committee presided over by my right hon. and gallant Friend the Joint Parliamentary Secretary to the Ministry of War Transport. All Departments come to this Committee, and allocations are made for each quarter in respect of all materials of all kinds. There is no competition and no disorder.

REGIONAL PRODUCTION BOARDS

Perhaps in order to complete the picture I may say a word or two about the regional production boards. The more we can get manufacturers to use them, the better work they will do. The essential purpose and object of the regional board is not so much to deal with the main contractors, the great businesses, but to arrange the use of the capacity of the small men. In London there are several of them operating like ticket exchanges, where a man who has unused capacity available can be put into touch with the man who requires it. That is spreading throughout the country. The object is to organise continually to see whether it is possible that when machines are unused, those who have the unused capacity can be put into touch with those who need it. Time is of the essence of this business; unless it is done in two or three days, a week's or a fortnight's work has gone.

CONCLUSION

We have been faced with the task of converting the whole economic organisation of the country from a basis on which it was regulated by the pull and push of the price system to an economy in which every consideration must be subordinated to the maximum production of weapons of war.

We are confronted with an enemy who devoted himself to this very task for a large number of years and achieved it by ruthless means, overthrowing as he went everything that matters in the social life, of a country. It may be that we move slowly, but I am convinced that we are building upon a more secure foundation. The organisation we are producing is built upon the solid rock of democratic consent, and it will perhaps endure when the harder and more brutal Nazi totalitarianism has cracked under the stress of modern war.

Repair of Cast Iron Low Pressure Evaporator

RECENTLY, at a power station in the London area, the cast iron body of an evaporator was cracked and broken in service as a result of water hammer being set up in the vapour line. The damaged body of the evaporator is shown in Fig. 1. To have obtained new castings would probably have necessitated a long delay, possibly of some months, during which the evaporator would have been out of commission. The British Oxygen Company, Ltd., was therefore approached and undertook to make a repair by welding. The repaired evaporator, back in service within two weeks after its removal from the boiler-house to the welding shop of the power station is shown in Fig. 2.

FIG. 1—DAMAGED EVAPORATOR BODY

The evaporator has a heating surface of 400 square feet and an output of 5000 lb. per hour when supplied with steam at a pressure of 10 lb. per square inch. It is fed with softened water, which, when evaporated and condensed, is used to supply make-up for boiler feed purposes. The normal working pressure of the shell is 1–2 lb. per square inch, and of the steam heating coils 10 lb. per square inch. The overall dimensions are about 8ft. in height and 4ft. 9in. in diameter, and the whole weighs approximately 4½ tons, with in effect a flat side formed by the door. The door is curved so that it bows inwards a distance of approximately 3in. and is stiffened with five heavy cross webs, each 1½in. thick. Its jointing face is 2½in. wide. The body of the casting is approximately 1⅜in. thick, stiffened with five ribs, each approximately 1½in. thick. Only the centre and bottom ribs pass round the circumference. The bottom of the casting is reduced or necked down. It has a fairly heavy supporting flange on the bottom, the top end being of full diameter with a flanged jointing surface. The door

FIG. 2—REPAIRED EVAPORATOR IN SERVICE

was fractured across from the top left-hand corner, the crack running towards the centre and then gradually returning to the bottom left-hand corner, the door thus being in two pieces. A large section of the body was also broken completely away, including the jointing face behind the left-hand side of the door, the bottom extremity of the fracture just running in to the radius of the necked supporting piece.

It was decided that an effective repair could be undertaken by bronze welding by the two-operator vertical welding method. This decision involved double vee preparation to give an approximate included angle of 90 deg. on either side of the material. The fracture was prepared in this form with pneumatic chisels and the surfaces around all fractures were cleaned back with a grinder for a distance of approximately 1in. to 1½in. on each side of the vee. To enable the fractured door to be aligned it was lightly bolted back upside down for location, as there was

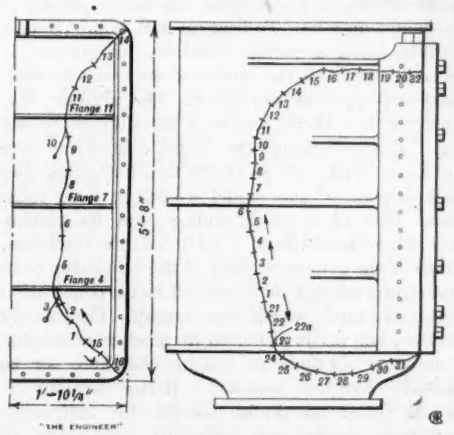
FIG. 3—PREHEATING DOOR WITH BUNSEN FLAMES

no opposing face of the casting to carry the smallest piece of the door. It was considered desirable to preheat the whole casting to some 300 deg. Cent. before welding began. A coal gas main was therefore laid on and four home-made bunsens attached. Heating of the door casting is to be seen in Fig. 3. Owing to the coal gas line being of 1in. diameter only, it became apparent that it would not be possible to preheat to the temperature desired, and it was therefore decided to commence welding as soon as practicable. To compensate for the lower temperature of preheat

it was also decided to resort to hammer stretching of the bronze weld deposit, so inducing compression rather than tension in the joint. When the temperature had risen to about 100 deg. Cent. welding was begun below the bottom web and at a distance of about 9in. from the end of the fracture, the operators working one on each side—Fig. 4. After welding a distance of 6in. welding was discontinued and the deposit lightly hammered. Welding was then again begun and a further short stage of 6in. to 9in. treated in the same manner, this procedure being continued almost to the far end. The door was then removed and the top corner welded and it was finally turned

FIG. 4—WELDING CRACK IN DOOR

upside down for the short unwelded piece to be completed in the opposite direction, as shown by the sketch—Fig. 5—of welding stages. This procedure was adopted to minimise distortion from the "draw" of the weld metal. After the welding of the door had been completed it was arranged on the floor upon a row of loose fire-bricks. More bricks were then arranged around the outside of the door in the form of walls, the height of which was slightly greater than the top of the casting. The top of this temporary muffle was covered with sheet iron and all bunsens relit and allowed to burn for about half-an-hour to obtain an even heat throughout the casting, which was then left to cool down very slowly. After the door had thoroughly cooled it was found that the bolting down face had pulled out of alignment



FIGS. 5 AND 6—WELDING SEQUENCES FOR DOOR AND BODY

approximately $\frac{1}{32}$in. and that owing to percolation of bronze between the fractured faces the overall size of the door was slightly full. This slight malalignment was overcome by inserting a thicker jointing material on the low face and by slightly drawing the holes as and where necessary.

The time actually spent upon welding this section of the job was seven hours, the five operators having worked in shifts of approximately half-an-hour, the fifth man cutting in to vary the pairs and give as much relief as possible. Two 25 cubic feet consumption blow-pipes were used and the length of welding was 8ft. 4in. over a metal thickness varying from 1$\frac{1}{4}$in. to 1$\frac{3}{8}$in. apart from thickness of the flanges on either end of the weld.

THE MAIN CASTING

The faces of the door having been cleaned up, it was bolted back into position on the main casting to enable the piece broken, from the main body to be fitted back in position. This piece was held in place by lightly bolting it to the door. The very slight distortion which had occurred in the door did not prevent its satisfactory location, although the broken edges in the body were rather less than $\frac{1}{4}$in. out of level. It had, of course, been double veed to 90 deg. included angle and cleaned so that it merely became necessary to begin the preheating once it was so positioned. In order to obtain equal heat in the casting throughout before welding and in view of the fact that four bunsen burners were of insufficient power for the job, four electric radiators were placed inside the casting. The top of the casting was covered over with sheet iron and in turn covered with sandbags filled with asbestos lagging. Sandbags filled with asbestos lagging were then built around the outside of the job and to keep them in position were tied around with ropes. The radiators were switched on at about 4 p.m. and were switched off at 7.30 the following morning. This arrangement produced uniform heat in the casting to approximately 70–80 deg. Cent. The sandbags on the side of the weld line were then removed and the same welding and hammering sequence which had proved successful on the door was adopted on the casting body. To increase as far as possible the general heat in the work the four bunsen burners were kept alight, so producing a current of warm air passing up through the casting.

Welding within the interior of the casting soon became a somewhat distressing operation for the welder, and in view of the discomfort and the fact that the total weld length was almost twice as long as that for the door it was decided that the welding stages should be restricted to approximately 4in. to 5in. at a time, followed by hammering. It was also

FIG. 7—COMPLETED SEAM AFTER LIGHT HAMMERING

found that this shorter length of weld retained a better general heat for hammering and stretching of the weld metal. Hammering both on the body and the door was started in the weld crater at a dull red heat and continued downwards over the last section of deposit simultaneously from both sides. A total number of thirty-two weld sections were involved in completing this fracture, the casting being turned around to obtain a vertical joint as and when necessary. The sequence of operations can be seen from the sketch Fig. 6. In order to equalise the casting temperature after welding the same arrangement as for preheating was used. The casting was covered up and the radiators were switched on immediately after welding had finished at 8 p.m. They were kept on all night and switched off at approximately 7.30 a.m. next morning. The actual welding time to complete the 15ft. 6in. of weld was eleven hours with the five operators working alternately in pairs.

Subsequent to repair the shell was subjected to a hydraulic pressure test in the presence of a boiler insurance company's inspector and proved satisfactory. The pressure applied to the shell and maintained for twenty-eight minutes was 15 lb. per square inch gauge, and that applied to the steam side was 20 lb. per square inch gauge for a period of sixty minutes. In both cases the results proved satisfactory.

The total amount of materials used to complete the job was 65 lb. of "Bronzotectic" $\frac{1}{4}$in. diameter rod, 475 cubic feet of oxygen, 425 cubic feet of dissolved acetylene, plus the coal gas used for preheating and the electricity for radiator heating. The total number of man hours covering preheating, welding and post-heating was 110. As it was necessary to prepare and clean all joints before welding, the preparation time was somewhat greater and amounted to a matter of 140 man hours. Refitting the door after completion of all welding operations necessitated a certain amount of time spent on facing the joints and drawing the holes previously mentioned. A slight modification was made to the coil-supporting rack due to the small difference in location of the respective parts. For costing purposes, approximately 40 man hours for the above must be included. The total cost was therefore in the region of £60, approximately £40 for labour and supervision and £20 for materials. The above repairs were undertaken for the Northmet Power Company.

Foundries After the War*

A FOUNDRYMAN is essentially a man who learns from experience, and our experience of previous wars, whether vicariously by our reading of history or directly, as in the case of a number of us, who were engaged in the last Great War, seems to show that, however dislocating they may be at the time, wars are only episodes in the general progress of mankind. If, therefore, we continue our habit of basing our future practice on experience, we must be led to the conclusion that whatever setbacks the present war may produce, whatever discomfort or sorrow we may feel as individuals, the general progress of mankind will not be impeded, and our efforts, as scientists, and producers of commodities for the amelioration and advantage of our fellow-men, will in the long run be in nowise diminished. It may be difficult to realise this when, on the one hand, the skill and labour of our industry contribute to the strength of the perverted activities of the Dictators, and on the other hand, to our own power that will assist the natural overthrow of all Dictators.

When hostilities cease and, later, when the vast numbers of men and women engaged directly and indirectly for war purposes revert to peaceful pursuits, considerable forethought will be necessary to guide the change. The problem is exactly of the same magnitude as the change from peace to war, but operating in reverse, so to speak. Its speed will probably be no greater. The conclusion, therefore, is that it is almost inevitable that "control" will persist for some years after the war.

For my own part I regard this as desirable. Apart from war conditions, amalgamations into big units and co-operation amongst smaller units were growing tendencies. I am not convinced that schemes of nationalisation and socialisation of all industries have reached a stage of technique where it could safely be said that they would be accompanied by a higher standard of living; but I certainly am convinced that the popular school of economics, to which the city in which we are meeting gives its name, is out of date and inapplicable to modern conditions. In other words, in large well-established industries such as ours there will be no more *laissez-faire*, even though the devil may still take the hindmost.

A positive solution is particularly difficult when a fundamental economic basis is not clearly established. Though the ambitious and the materialistic-minded amongst us may say that the monetary reward should be proportionate to our effort, the actual fact is that most of us work because we have the habit of it, induced by the necessity for meeting our day-to-day responsibilities, and because we like it. I remember an old foundry foreman, working under me, who said, when given an unpleasant job: "If I weren't doing that I'd be doing summat else," and he would depart, cheerfully grumbling, and do the job well. I will not assert that the monetary reward has no bearing upon the effort, but I do emphatically say it is not the primary consideration. I would put a sense of security before it, but even the apprehension of insecurity is frequently an example of meeting trouble half-way. Much more important is the sense of enjoyment and satisfaction in doing the job itself.

As far as the outward effects of post-war conditions upon us as members of the foundry industry are concerned, I have already alluded to the probability of the continuation of control. Control, in our case, will have to be particularly widespread, as we very rarely sell our products direct to the final consumer. For the most part our products are raw materials upon which there are numerous operations, such as machining and assembly. Hence from the point of view of the market—without which we cannot produce—any national plan to serve the foundry interests cannot restrict itself to the foundry interests alone. It will have to form part of a much wider plan. The same, however, does not apply to the actual operations of production, wherein we as a technical institution are mostly concerned. Here the trade must have individual consideration, though no doubt the methods employed will conform with the general principles that may be laid down for similarly placed industries. The characteristic feature of the foundry trade is one that will make any national plan of production very difficult. I allude to the participation in the industry of a comparatively large number of small, privately owned, foundries. If the small foundry can deliver to the market better and cheaper castings than the large one, such castings will be made in small foundries.

SALE OF COKE OVEN GAS.—The surplus by-product gas from coke ovens recently started at the Gartsherrie furnaces, Coatbridge, is to be sold to the Coatbridge Gas Company. There are already four similar schemes in the West of Scotland.

* From Major Richard Mills' Presidential Address to the Institute of British Foundrymen, Manchester, July 12th.

The Engineer

JULY 18, 1941

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With the object of conserving paper, the number of copies of the Index to Volume CLXXI will be limited. Copies will be sent to all Institutions and Public Libraries on our mailing list and subscribers may obtain copies on application gratis and post free.

PRODUCTION

THE two days' debate in the House of Commons, in Committee, last week is too important to overlook and too long to discuss in detail. It ranged over a great number of subjects, was often purely critical, sometimes constructive, and now and then personal. Labour questions were barred, but the Chairman had frequently to call speakers to order for referring to them. He must have found it hard to decide where the embargo began and ended, and, as a matter of fact, whether they were in order or not, several speakers discussed labour matters; indeed, it is impossible to see how that could have been avoided. The most notable of the constructive proposals was that a single Minister, at the head of a new Ministry of Munitions, with a "wider horizon than the heads of the three Service Supply Departments," should be appointed. Mr. Garro Jones, who opened the debate, put this proposal forward, and found the support of several later speakers. The other constructive suggestions dealt principally with details, as, to take a couple of examples, that representatives of the workpeople should co-operate with management in the consideration of factory problems, and that when there was an unavoidable hold-up in shops the men or women should be told to take a holiday on pay instead of being expected to stand by their idle machines. One other constructive proposal of great interest must not be overlooked. It was that a Corps of Aircraft Constructors, similar to the Royal Corps of Naval Constructors, should be established. The reply to the first day's debate was made by Mr. Harold Macmillan, Parliamentary Secretary to the Ministry of Supply. He covered very skilfully most of the points that had been raised, and we have thought it worth while to give extracts from his speech in another place in this issue. Despite some purple patches, the debate on the second day (Thursday) was of a lower quality. It also ranged over a wide field, but there seemed to be more verbiage and the atmosphere was more political. Lieut.-Colonel Moore-Brabazon, Minister of Aircraft Production, replied.

A feature of the whole debate was the number of anecdotes related by the speakers. Each of them appeared to be able to adduce two or three flagrant examples of defects of one kind and another. That all these examples would bear critical examination may be doubted. Some of them were manifestly exaggerated, some were based on hearsay, and some, it may be suspected, dealt with matters that have been put right already or that are now being corrected. Others touched upon subjects outside the proper scope of the debate, subjects connected rather with military tactics and strategy than with supply. An outstanding instance was the contention by Lieut. Brabner that "we must make up our minds, from a productive point of view, whether we are going to beat the Germans by obtaining decisive superiority on land or in the air," and then go all-out for one or the other. Yet, considering the debate as a whole, it did confirm, what everyone knows, that production is still far short of one hundred per cent. efficiency. What it did not do was to give credit for what has been achieved. The organisation has been in existence on a war footing for less than two years. When we consider its magnitude and the diversity of the work it has to do, it is not surprising that there have been many mistakes. Mr. Macmillan truly remarked that any private firm of but a fraction of the size would be proud indeed if it reached so high a standard in so short a time. Continual improvement is essential, and despite the pessimistic atmosphere of the critics we are confident that it is being made daily. It is the familiar practice of this country to paint itself always worse than it is. We are very apt to concentrate our attention on the empty half of the bottle and to overlook the good wine that still remains. Everyone is conscious of the faults and wishes sincerely to see them removed quickly, but in justice to the Government Departments and to hundreds of firms which have done and are doing admirable work, and to the thousands of workpeople who are giving of their best, the achievements ought to be recognised and applauded. There is still a vast deal to be done, but that does not mean that a still vaster deal has not been accomplished. Stressing the defects without giving credit for accomplishments may produce a wrong impression abroad. Mr. Churchill is so disturbed by the possibility of that occurrence that on Tuesday he told the House of Commons that another day would be given to the debate on production, and that he himself would open it. It is his purpose, manifestly, to show and to prove that things are not so bad as they are painted.

Freedom of speech is an essential factor in democracy. We do not even ask that the speech should be subject to the usual laws of evidence. We allow every man a right to express his own opinions, even if they will not bear close examination. The theory is that mistakes will quickly correct themselves; that the bad half-crown will be nailed to the counter as soon as it is uttered. The House of Commons is as free in this respect as Hyde Park. Fortunately, we have at this time a Committee which examines critically such charges as those brought in the present debate, winnows the wheat from the chaff, and bases recommendations on its findings. That is the Select Committee on National Expenditure. It has now issued sixteen reports, and there is hardly a subject raised in the debate which has not been studied by it. It is an extremely critical and outspoken Committee, and is well aware of the faults in the present system. But its reports are carefully weighed. They are without bias and are notable for clearness and commonsense. It may be doubted if the general public has paid sufficient attention to them; it may also be doubted if the Government has done so. We commend them earnestly to the attention of all those who are ready to be influenced by logical arguments.

Air and Sea

MUCH light is being thrown in the course of this war on the long-debated problem of the respective fighting powers of ships and aeroplanes. In many of the encounters that have taken place both types of craft were present on the two sides, and it is difficult to disentangle their respective offensive and defensive qualities, but in the struggle round Crete nearly all the ships were on one side and nearly all the aircraft on the other, so that one can expect some definite answer to the question how far air attack can do vital damage to a warship which knows how to defend itself. One does not, of course, expect the Cretan episode to throw light on the battleship question, since capital ships were not involved; in any case we know already from the sinking of so modern a ship as the "Bismarck" that the torpedo aeroplane is certainly capable of winging the largest quarry and causing it to fall a prey to naval power in pursuit. Also there is good evidence that the armoured deck of some modern capital ships can resist a bomb from whatever height it is dropped. What the Cretan experience throws light on is the relationship of air attack to the defensive power of the lesser ships, the cruisers and the destroyers, of which we lost several.

The penetrative power of a given bomb is a function of its striking velocity. This is at its maximum when the aeroplane makes a level attack from a great height; but, owing to the enormous increase in air resistance when the velocity of sound is approached, no greater striking velocity than about 1000ft. per second is attainable, whatever the height may be. To beat an A.P. bomb coming at this speed a certain thickness of armour is necessary and this the armoured deck of a modern battleship aims at providing. The armour of a cruiser is less thick, and it is not difficult to see why. If one considers the simple case of an exact half-scale model of a 48,000-ton battleship the displacement of the model would be 6000 tons, about that of a small cruiser, and its plating everywhere would be of exactly half the thickness. Hence if the armoured deck of the battleship were just strong enough to withstand bomb penetration that of the model would be too weak. The remedy is clear, one needs either to fit thicker protection—at some sacrifice in weight elsewhere—or to discover tougher armour. Better armour is at all times no doubt sought for diligently, but one cannot now wait for that way of escape to be available. So it is necessary in the design of new ships that naval architects should consider every possible means by which weight can be saved, whether by the use of light alloys or otherwise, in order to add to the existing armour protection against attack from the air. Cruisers are smaller targets than battleships, and are more difficult to attack, but they are vastly easier to hit than destroyers, whose power of rapid manœuvre added to the smallness of deck area makes then elusive objects. Aeroplanes of the dive bomber variety are a lesser menace since, although they are much more likely to get hits, especially on small targets, the striking velocity is much less and the angle of impact far from vertical—unless the falling bomb hits by chance some part of the superstructure and is deflected to a more nose-down altitude. Incidentally, such deflections are common and may make the bomb take up almost any attitude; once an unexploded bomb

was found in a ship with its nose pointing up to the sky!

The opinion is sometimes expressed that a higher striking velocity must surely be attained when the bomb is released from a very fast power dive than when dropped during a high-level attack. This can be seen to be fallacious, since the terminal velocity of any bomb is much higher than that of any aircraft, and on a long fall the sooner they separate the more rapidly will the bomb gain speed. Repeated hits from bombs dropped by diving aircraft are a nuisance and a danger to personnel, but great penetrative power they have not, and it is therefore possible for the vitals of the ship to be protected. Moreover, diving aircraft are much easier targets for the defending guns than are high-flying craft and their losses are usually large. It must be conceded that great courage is required in the making of such attacks, and great steadiness on the part of the defending gunners. The best deterrent of all, however, is the presence with the ships of an adequate number of fighter aircraft. Co-operation of that kind is valuable beyond measure; the supreme importance to the Navy of the Air Arm is one of the greatest of the lessons so far taught to us by the war.

Obituary

SIR KEITH ELPHINSTONE

IN our last issue we recorded briefly the death at his home, 5, Kingston House, South Ennismore Gardens, S.W.7, on Sunday, July 6th, of Sir George Keith Buller Elphinstone, the chairman of Elliott Brothers (London), Ltd. Sir Keith was born in Edinburgh and was educated at Charterhouse. He served his apprenticeship with the firm of Woodhouse and Rawson, and also with the Brush Electrical Engineering Co., Ltd., after which he worked on the staff of the late Mr. S. J. de Ferranti in the early days of high-tension electric supply from central power stations.

In 1891 he acquired the telegraph instrument business of M. Theiler and Sons, and in October, 1893, joined the firm of Elliott Brothers as partner, on their taking over the entire business of M. Theiler and Sons. From 1916, when the original firm of Elliott Brothers was registered as a private limited company, Sir Keith acted as joint managing director.

In September, 1917, his efforts in connection with the design of fire control equipment for the Admiralty were recognised by his receiving the honour of Officer of the British Empire, and in March, 1920, he was gazetted Knight Commander of the British Empire. In January, 1934, Sir Keith was elected chairman of the present company of Elliott Brothers (London), Ltd., in whose service and of the original firm of Elliott Brothers he had worked for over fifty years. Up to the time of his death, after a long illness, Sir Keith Elphinstone was chairman of the company.

ERNEST KILBURN-SCOTT

THE British electrical industry has lost one of its pioneer workers by the death of Ernest Kilburn-Scott, who has just died at his home, 38, Claremont Square, London, N.1, at the age of seventy-three years. Kilburn-Scott came of a Yorkshire family and received his education at the Yorkshire College and Finsbury Technical College. He was apprenticed with R. Kilburn and Sons and John Fowler and Co., of Leeds, and later became assistant to the late Wilson Hartnell, the Leeds consulting engineer. His next appointments included that of head draughtsman to W. T. Goolden and Co., after which he joined the Electric Construction Company. For some years he was dynamo designer to the Brush Electrical Engineering Company, after which he joined the firm of Johnson, Phillips and Co. At one time he was chief inspecting engineer with Robert Hammond, and he then became the manager in the United Kingdom and the Colonies for the International Electrical Engineering Company, of Liège, Belgium. As advisory engineer to Harper Brothers and Co., he was concerned with the construction of the Bath tramways and the North Wales Power Company.

Following that appointment he spent some years in Australia, where he served on various committees of inquiry which were set up by the Government of New South Wales. His work in Australia included expert evidence in legal cases, one of which was the rating appeal with regard to the City of Bendigo electric power and tramways undertaking in Victoria, Australia. He then accepted the lectureship in Electrical Engineering at the University of Sydney, New South Wales.

On his return to this country Ernest Kilburn-Scott was appointed to University College, London, and lectured on Electrical Engineering Quantities and Estimates at the Northampton Engineering College. He was consulting engineer to Atmospheric Nitrates (Kilburn-Scott Patents), Ltd.

During the last war he was engaged for some time as Labour Officer with the Ministry of Munitions, and his later appointments had to do with the expedition of shell production and the use of nitre-cake in the metal trade processes. He designed nitrate plants for the production of explosives for Kynoch's, Ltd., of Birmingham, and for the British-America Nitrates Company of New York.

In 1920 he went to America and made several expert reports on public utility and industrial companies. He wrote for American technical papers and gave many lectures in Great Britain, America, Australia, and Canada on the manufacture of nitrates from the air. He also gave expert evidence before the Senate Committee on Nitrates at Washington. He wrote freely for the British and American technical Press, and his subjects included such matters as electrical design, refractories, electro-chemistry, and metallurgy. For eight years he was editor of the "Proceedings" of the Association of Mining Electrical Engineers. He was a member of the Institution of Electrical Engineers, and associate member of the Institution of Civil Engineers and a Fellow of the American Institute of Electrical Engineers. He was an early member of the Newcomen Society, contributed several papers to its "Transactions," and often took part in its debates. He was an enthusiast on the history of the industries of Leeds, and wrote much about them.

FRANK PROUT

WE regret to have to announce the death recently of Mr. Frank Prout, M.I. Mech. E., managing director of Lancaster and Tonge, Ltd., Manchester. Mr. Prout was born in 1870. He was the son of Mr. Joseph Prout, a mining engineer, who managed a group of mines, owned by Lord Brassey, in Italy. Frank Prout served his apprenticeship with the Continental Lead and Iron Company, Pertusola, Italy, and the National Construction and Armament Company, Ltd., Barrow-in-Furness, where he was largely employed on shop tests on Admiralty work and on sea trials. He was afterwards employed by Messrs. Swan, Hunter, John Penn, and Humphrys and Tennant. In 1898 he was appointed works manager to Lancaster and Tonge, Pendleton, Manchester, and became managing director in 1937. Mr. Prout always maintained a keen interest in the marine engineering side of the business, and was responsible for the development of the "Lancaster" restrained piston rings. He was a man of great energy and wide practical experience. He was well known and was held in the highest respect by all who were associated with him.

Literature

Theory of Plates and Shells. By S. TIMOSHENKO. London: McGraw-Hill Publishing Company, Ltd., Aldwych House, W.C.2. Price 42s.

No book by Professor Timoshenko is likely to be missing for long from the reference shelves of any student of applied elasticity, and his latest book on "The Theory of Plates and Shells" is a welcome addition in a specialised field which is steadily increasing in importance.

As was to be expected by the nature of the work under review, the book had to become in part a catalogue of the solvable cases taken from the existing technical literature, of which, of course, a considerable contribution has come from Professor Timoshenko himself. As a consequence, the author was left with less freedom of expression and presentation than in some of his past works. Nevertheless, the book retains many of the admirable features of Professor Timoshenko's other volumes, the clear and attractive set out, the usual first-class diagrams, and what is so important in the field of application when the calculations are so often both complicated and laborious, the usual abundance of tables and curves to help in the application of the results obtained.

An opening chapter on the bending of flat plates to cylindrical surfaces is followed by a chapter on the pure bending of flat plates, which, as is usual, is the basis of much of the approximate theory which follows. The next chapter on the bending of symmetrically loaded circular plates lists most of the standard cases and includes a brief discussion on the method of allowing for shear effects and for the local stresses due to "concentrated" loads. An important chapter follows in which the fundamental equations for the bending of plates due to any loading system are developed. The development is clearly set out, and a good discussion on boundary conditions follows, as in the corresponding chapter on the author's work on elastic stability. The chapter includes a reference to the membrane analogy and a short comparison of the formulæ obtained with the corresponding equations of the rigorous theory of the deflection of plates.

A considerable section of the work then follows in which the equations are applied to a large number of loading conditions—first, of simply supported rectangular plates; then plates with varying edge conditions; and, finally, a rather shorter discussion of many of the non-rectangular plates for which solutions are known, including the non-symmetrical bending of circular plates.

A short discussion on the effect of lateral loads on the deflection of plates includes a brief mention of the consequential question of buckling, which subject, of course, is much more fully dealt with by the author in his book on elastic stability, mentioned above.

As is usual, all the above work is based on the assumption that the deflection of the middle surface of the plate is small compared with the thickness, and the part of the book on flat plates is completed by one chapter on the deflection of such plates when an allowance has to be made for the stretching of the middle surface.

The remainder of the book is concerned with the stresses in shells, first, when the direct stresses outweigh the bending effects, and then, more generally, for cylindrical shells and other special cases when the effect of bending is included. This latter part of the book is not quite as comprehensive as the earlier portion on flat plates. A more detailed study of discontinuity stresses, both between flanges and cylindrical shells and dished ends and cylindrical shells, especially in connection with the placing of such items as welds, would have been welcome. A brief mention of the approximate effect of local holes, which is often of considerable importance in plate and shell design (in normal pipe flanges, for example), would have been of interest if it could have been made.

One must add that Professor Timoshenko retains his usual habit of keeping constantly in mind the application of the theoretical results to practice, not only by the frequent supply of tables and curves mentioned above, but also by giving in detail approximate methods of solution and the order of the errors involved whenever he feels such approximations or simplifications can usefully be employed.

BOOKS RECEIVED

Materials Handbook. Fourth edition. By G. S. Brady. London: McGraw-Hill Publishing Company, Ltd., Aldwych House, W.C.2. Price 35s.

The Spectrochemical Analysis of Metals and Alloys. By F. Twyman, F.R.S. London: Charles Griffin and Co., Ltd., 42, Drury Lane, W.C.2. Price 21s.

The Aviation Mechanic. By C. Noncross and J. D. Quinn, jun. London: McGraw-Hill Publishing Company, Ltd., Aldwych House, W.C.2. Price 21s.

Practical Tunnel Driving. By H. W. Richardson and R. S. Mayo. London: McGraw-Hill Publishing Company, Ltd., Aldwych House, W.C.2. Price 35s.

Mechanical Vibrations. By J. P. Den Hartog. Second edition. London: McGraw-Hill Publishing Company, Ltd., Aldwych House, W.C.2. Price 35s.

Surveying. Third edition. By R. E. Davis and F. S. Foote. London: McGraw-Hill Publishing Company, Ltd., Aldwych House, W.C.2. Price 35s.

Design of Concrete Structures. By L. C. Urquhart and C. E. O'Rourke. Fourth edition. London: McGraw-Hill Publishing Company, Ltd., Aldwych House, W.C.2. Price 31s. 6d.

The Blue Book—The Electrical and Engineering Trades Directory, 1941. Fifty-ninth edition. London: Benn Brothers, Ltd., Bouverie House, Fleet Street, E.C.4. Price 25s. net.

Time and Motion Study. By S. M. Lowry, H. B. Maynard and G. J. Stegemerten. Third edition. London: McGraw-Hill Publishing Company, Ltd., Aldwych House, W.C.2. Price 35s.

Letters to the Editor

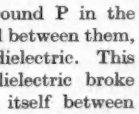
(We do not hold ourselves responsible for the opinions of our correspondents)

ATOMIC INDUCTION

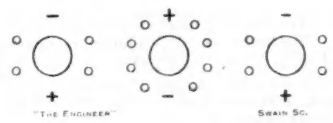
SIR,—I read with considerable appreciation in your columns Professor Andrade's lecture on the mechanical properties of solids, particularly so as I had spent many hours as a student of geology examining the properties of minerals in thin sections under the microscope, where, of course, the structures of the translucent crystalline material forms are generally clearly outlined as regards their cleavage planes, twinning, and polarisation, &c. One thing that puzzled me was the fact that each individual element was able to manifest itself in three regular physical forms, namely, as a solid, a liquid, or a gas, in each case merely by coming within a definite temperature and pressure range. Also, it seemed strange that the structureless nature of a gas or a liquid should not also be the property of a solid on cooling, as in the case of obsidian; in other words, why should a crystal form appear, and why should its faces adopt definite angles to each other and rigidly maintain them?

It seems to me that any possible explanation would appear to lie in a fuller investigation into the electrical properties of the atom itself. If the protons of two atoms are charged similarly, the atoms will naturally repel each other; what, then, is the cause of inter-atomic attraction?

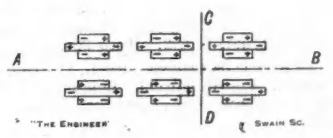
If P is a proton and E an electron spinning round it, and x is the radius of the electronic orbit, then it is perhaps reasonable to expect the atom in question to behave in principle like a frictional electricity induction machine of the Wimshurst or Nairne type, in which the ether to a depth of x represents the dielectric. Every revolution of E round P in the latter event would build up a potential between them, producing in x a polarisation of the dielectric. This charge would build up until the dielectric broke down and the potential discharged itself between E and P. This discharge would take place theoretically every so many revolutions of the electron, and as the inductive field round the atom would be proportional to the magnitude of the charge generated, so a pulsating magnetic field of definite frequency per second would be the result for that particular atom. The frequency would possibly be decided by the number of electrons in the atom and the time taken to break down the dielectric by each one.



Faraday's theory of induction, to the effect that inductive action is not action at a distance, or rather at no greater distance than between two molecules, which he illustrated in his experiment with the silk filaments in a vessel of turpentine, and which Matteucci supported in his experiments with leaves of mica, can here be applied to the atoms in one of the molecules. If the frequencies of the inductive fields of the atoms in question are resonant, or in step, then the atoms will form a molecule, because they will eventually attract each other at the same instants of time. Being in the earth's magnetic field, the atoms will each have a positive and a negative pole, and a molecule might then consist of an arrangement of atoms such as :—



It would not be illogical to continue the reasoning to the structure of the molecule, and suggest that in a molecular system atoms would group themselves together so that they were eventually in resonance in the particular structure taken up, and so orientated that their respective poles attracted each other in harmony, thus :—



By representing the atoms as small bar magnets grouped as above to form six molecules of three atoms each, it is possible to suggest, from the experience of being able more easily to slide bar magnets together along a path parallel to their polar axes than to pull their poles apart when placed end to end, that the line A B would thus become a cleavage plane, or plane of slip, and C D a line of fracture. A complicated crystalline molecule with an odd number of atoms would not necessarily take a symmetrical form, and this might account for the pyro-electric series, the hemihedral group of which tourmaline is a classic example. It is to be expected that all the atomic fields would combine to form a common molecular field with + and − poles located within the molecules.

Kuppfer found that increase of temperature always produced a diminution of magnetic force; with a bar magnet 2½in. in length he found that with an increase of each degree of temperature the duration of 800 oscillations was 0·4in. longer. If n be the number of oscillations at zero and n' the number at t degrees, then $n=n'(1+c\,t)$, where c is a constant depending in each case on the magnet used. If this principle can be applied to the atoms of the various elements, with c varying for each element in question, then possibly it would explain the behaviour of matter in forming a solid, liquid, or gas as the temperature and pressure rose. If the atomic inductive field weakened, the inter-atomic force of repulsion between the protons and electrons might be expected to play a greater part and force the atoms or molecules further apart. Losing their pole strength to this degree, the molecules would no longer orientate themselves into the particular pattern of their solid material structure, rather like the difference between magnetised and non-magnetised iron filings, and would, in turn, become a liquid and then a gas. Questions of latent heat and the eutectic point would need to be viewed in the light of energy absorbed in the alterations in field strength of the molecules involved.

The effect of light on an energised molecule generating its own field is more easily understood if the wave theory of light is accepted and its phenomena regarded as being due to disturbances and changes in the polarised dielectric between the protons and the electrons, caused by nodal and anti-nodal density fluctuations in the ether brought about by the light waves. Fluorescence might thus be a kind of molecular aurora borealis on a sub-microscopic scale.

In so far as heat can also be polarised like light, established originally by the experiments of Malus and Berard, it might possibly be due to these wave motions of heat in the ether, also causing similar density changes in the polarised dielectric, which bring about the changes in pole strength of the molecular and atomic inductive fields.

For the sake of clarification, the foregoing suggestions might be stated tentatively :—

(1) The movement of the electrons round the proton of an atom generates a pulsating electromagnetic field which gives the atom a + and − polarity, and which has a definite frequency for that atom.

(2) The frequency of the atomic field is a mathematical relationship of the atomic number of the element.

(3) The strength of the molecular inductive field is governed by the temperature and pressure obtaining in its environment.

(4) The physical form of matter is governed by the strength of the atomic and molecular inductive fields.

MICHAEL BENKERT.

London, E.C.3, July 9th.

GOVERNMENT INDUSTRY AND LABOUR

SIR,—"An Industrialist" succeeds in being gloomy and impatiently critical, but little else is to be gathered from his article. He does not seem to appreciate the economic and psychological point of view and rather stresses certain features of the war effort which have not developed satisfactorily. What at the outset he apportions as "blame" is merely the narrow point of view of our national characteristics. To be precise, the British temperament is such that radical changes develop slowly but surely, and changes in any stabilised order are undertaken gradually and with understanding. To imply that efficiency means hurry or an acceleration (time period) of change over is muddled thinking. The problem of rapid output of munitions and engines of war has been tackled boldly and under wartime conditions and stress; we have not had the advantages of military preparation under peacetime conditions, and the magnificent response of all branches of industry, employers and workers, has never been equalled in history. We all know that what has already been achieved can and will be improved upon, but that is no reason why at this stage we should look for someone to blame.

The greatest hindrance to the industrial effort is a direct result of our peacetime apathy of economic and social conditions at home. We, as individuals, have not only a love of freedom and justice, but a strong sense of individual worth and independence, force of character and pride of behaviour. It is rather unfair of "An Industrialist" to belittle the scrupulous care that civil servants take in not exceeding their functions. This is not due to timidity or incompetence, but arises in the limitations of appointed duty and *esprit de corps*. I know from a wide experience that within its operational limits it is most efficient and reliable, indeed, its most tantalising feature is its unerring reliability. In wartime, however, the Civil Service becomes swollen with additions to the staff unused to the machine, much as recruits to the colours. It takes time to absorb this influx, and productive effort appears to slow up. One must appreciate that the Civil Service works as a team and is scrupulous of the interests of all departments concerned and does not enjoy the much easier task shouldered by the managing director of a firm—whose authority is unquestioned technically or financially.

If before drawing rapid conclusions upon the behaviour of a class your contributor examined the subject most closely he would perhaps find the blame, if any, was individual. We, in this old country, have been educated to place too much reliance on the labels of a man's ability and not enough on his personality. At the present time we require men with punch, not academic alphabetical tails and influential social recommendation.

I gather from "An Industrialist's" article that he is rather hard on the craftsmen—his gloom seems so heavy that it must be unreal. The miners, shipbuilders and engineering mechanics have actually suffered cruelly from the apathy of the country during the deplorable state of the industries over many years of peace. The valleys of South Wales have had economic problems to solve that would have broken the hearts of less sturdy people. The shipbuilding communities of the Tyne, Wear and Clyde have for many years fought an unequal battle for survival; the submissions of the employers for Government help received little or no encouragement and the workers of this once thriving industry deteriorated through enforced idleness or drifted off into new channels of livelihood. A cry is now raised for these neglected workers to return, but what is the incentive after the bitter disappointments of the past? They are British and patriotic, but after all, what guarantees have been offered, as in justice they are entitled to, that the economy blizzard will not again land them in their former sorry plight? It is not necessary for a wise management to seek or implement compulsion. "An Industrialist" must know that respect, good treatment and able leadership are the best qualities in a management to gain confidence and service.

From a world-wide experience of engineering over several decades I have sufficient trust in my kind to know that to put a Britisher on his mettle is to find a man.

I hope I have helped to dispel a little the gloom of "An Industrialist," who is not a Dean.

Bath, July 12th. R. R. MINIKIN.

STEEL *v.* COPPER FIRE-BOXES

SIR,—As a former mechanical official of a number of American railways, I was particularly interested in the letter under the above heading in your journal of June 6th last.

For many years there has been controversy between the advocates of steel and copper fire-boxes. However, locomotive engineers, with few exceptions, have now recognised the advantages of steel, especially for use in boilers carrying high pressures. The most impressive example of this policy is the application of electrically welded steel fire-boxes, fitted with two Nicholson thermic siphons each, to twenty new "Merchant Navy" class engines, 280 lb. pressure, now under construction by the Southern Railway of England, the first installation in this country. In a paper read before the Institution of Locomotive Engineers in London on April 17th, 1940, Monsieur Chan, chief engineer of the French State Railways, says that "steel fire-boxes seem beyond all possible doubt to be indispensable for boilers working at high pressures."

Although supplies of copper have always been available in America, it has not been used for fire-box construction, but limited trials are said to have been

made for reasons other than mechanical. During my railway experience in America in charge of locomotive operation and maintenance, I had an opportunity to observe the behaviour of steel fire-boxes under extremes of temperature and varying water conditions.

At the time of the Great War I saw copper fire-boxes for the first time, in use on the Siberian and Japanese railways. In 1920 I visited Australia and found copper fire-boxes there on locomotives of the New South Wales Railway. I was informed that copper was standard practice in Australia; however, steel is replacing it, and a similar situation prevails in South America and the most important colonial railways. The South African Railways and Government Railways of New Zealand have used steel for many years; extensive applications have been made of Colville's Double Crown plate, which is giving excellent service.

Some locomotive engineers contend that steel is not suitable for fire-boxes of the narrow type, but my experience has been that whilst the wide fire-box is preferred for excellent reasons, satisfactory results can be obtained with steel applied to narrow boxes, provided the staying and other details are modified accordingly. Thousands of engines with narrow boxes of steel have been in use for years in the United States of America and other parts of the world, many of them operating on railways where native staff is employed.

The principal defect of the locomotive boiler is deficient circulation, and various means of overcoming the difficulty have been devised, but it is generally agreed that the Nicholson thermic siphon meets the requirements, and this is confirmed by the fact that over 19,000 have been fitted to boilers of engines on railways in America and foreign countries.

With a view of extending the use of thermic siphons on locomotives of foreign railways, it was arranged to manufacture them in Great Britain, so that it became necessary to find a local source of supply of suitable steel, having in mind the special characteristics required of such material. Careful investigation was made, and as a result it was decided to obtain it from Colvilles, who had previously supplied slabs of low-phosphorus and sulphur steel to America for rolling into fire-box plate. British-made siphons are now in use on many railways.

It must be understood that the specification does not guarantee the quality of fire-box steel any more than a recipe does a Christmas pudding; aside from selecting the raw materials, skill is required in the process of manufacture. The use of unsuitable plate, combined with unsatisfactory construction, is largely responsible for the failure of steel fire-boxes on some railways.

All locomotive engineers are aware of the progress made in recent years in the art of electric welding, and I have been impressed with the excellent welding of fire-boxes and tubes by native staff. There is no need to emphasise the advantage of eliminating riveted seams and the expanding of tubes which is so necessary in copper fire-boxes.

J. D. ROGERS.

London, W.C.2, July 10th.

"THE WORLD WE HOPE TO LIVE IN"

SIR,—I was interested in Lieut.-Colonel Kitson Clark's article in your July 4th issue, but suggest that the money side of the argument can be reduced to the statement that money is merely an ingenious system of accountancy by loose-leaf book entries, cheques, notes, and coins being duplicated by figures in bank books. Money is a means to the end that production should be directed, with the least possible friction, from field and factory to consumer. How the means should operate must be a matter for monetary experts, such as bankers, who might be licensed by the Treasury, much as retailers are now to be licensed by the Ministry of Food. Should they fail to produce the result of assuring a free flow of goods and services from producer to consumer, as fast as the goods and services are produced and required, their licences would be withdrawn.

Obviously, there must not be a return to the pre-war monetary methods, for they hindered rather than helped production and distribution. It is senseless to produce unless the product can be disposed of, and it is even worse that anyone should go short of what can be supplied in abundance.

J. E. TUKE.

Welwyn Garden City, June 8th.

ENGINEERS IN GOVERNMENT SERVICE

SIR,—As an engineer in an industrial post, I have been most interested in the letters in your correspondence columns on the subject of engineers in Government service.

Throughout the profession there are large numbers of engineers who could be employed much more usefully in working for the war effort more directly instead of being relegated to the "back room" or kept on work which could easily be carried on by a skeleton staff during the war.

In addition to this, since the commencement of the war there has been a tendency in industry for salaries to stand at their pre-war level, taking no account of the experience gained during the war period, which is often considerable among the younger members of the staff. In many cases the pay has actually been in effect reduced, due to the regular working of overtime without additional pay.

In the industrial world of to-day, which is run on a profit and loss basis, the questions of salary and status essentially go hand in hand, and it is the status of the engineer which governs his power to use the specialised knowledge which he possesses to the advantage of the rest of the community, especially in the present emergency.

From the report which you published a few weeks ago it appears that the Association of Scientific Workers is setting out to see what can be done to improve the position of the profession in this respect, and I shall be interested to hear more of its activities, and to follow its progress. J. A. N.

Cheshire, July 9th.

Airyx*

RECENT formation by four of the larger air lines of a company to survey the possibilities of air freight and express emphasises one new and developing frontier for aviation. The Douglas "B-19," now undergoing trials, is said to carry 18 tons of bombs and more gasoline than a railway tank car. Although this aeroplane, largest in the world, is scarcely typical, it emphasises the impetus given to construction of large aeroplanes, the type needed for freight, by military demand. After the emergency the experience will remain—and also huge construction capacity and organisation. Furthermore, large numbers of aeroplanes now being built for military service are similar to commercial types, and when not needed for military purposes would be usable for freight, although perhaps obsolete for passenger use.

There are not now enough aeroplanes in the world to make an appreciable dent in the mass of goods which an industrial country must move. The United States, for example, possesses perhaps 400 fast, up-to-date transport aeroplanes as compared with 4,000,000 trucks and 1,700,000 freight cars. Of the 550 billion ton-miles (excluding coastal shipping) rolled up in this country in 1937, air transportation, both express and mail, accounted for about 9,000,000. Although use of air express has increased sharply, the air lines get only some 3 per cent. of their revenue from express and about 32 per cent. from mail. By comparison, Class I railways get more than 80 per cent. of their operating revenue from freight and only 2·7 per cent. from mail.

However, an air freight line has operated in Texas for nearly a year, and one transcontinental air line, a product of the emergency, is primarily a freight carrier. This "line," the Army's Fiftieth Transport Wing, operates forty-four transport cargo aeroplanes on schedule over a route from Pennsylvania to the Pacific Coast and the Panama Canal. According to an article in *Business Week*, the aeroplanes used are similar to ordinary passenger transports in size, but with reinforced flooring, wide freight hatches and carrying an average 3200-lb. load. Principal cargo is aircraft engines. Special parts and materials are sometimes carried to manufacturers to relieve temporary bottlenecks.

In carrying capacity an aeroplane is most comparable to a truck and both are primarily suited to express and "L.C.L." (less than car load) freight, although the truck offers the definite advantage of door-to-door pick-up and delivery. The latest four-motored commercial land transports, few of which are now in operation, weigh about 50,000 lb., carry a useful load of about 15,000 lb. and cruise at about 200 m.p.h. These aeroplanes are designed primarily as passenger carriers, with freight relegated to the space and weight-lifting capacity remaining. If the aeroplanes were designed for cargo service and the seats, insulation and other comforts essential in attracting passengers were eliminated, the useful load could be substantially increased, for in 1939 these comfort items amounted to about 180 lb. per passenger. A truck may carry up to 30,000 lb. at perhaps 30 m.p.h. A modern box car easily transports 100,000 lb. and more, and while the average freight train in 1939 moved at only 16·7 m.p.h., the train load totalled 813 tons of cargo. A fast freight ship, though slower than a modern "merchandise" train, travels as fast as the average train and carries far more; the American "C-2" ships move almost 10,000 tons of cargo at 15·5 knots.

Present air express rates are five to seven times railway express rates. Among reasons for this difference are these:—Modern transport aeroplanes cost about 11 dollars per pound and are usually depreciated on the basis of a five or six-year life with a scrap value of 10 per cent. Much of this high depreciation rate, however, is due to obsolescence which would not affect a freight aeroplane; aeroplanes well over ten years old are still in service in some localities. Aeroplane engines cost approximately 9·40 dollars per pound and must be depreciated at a much faster rate, whether for freight or passenger use. Aircraft personnel, maintenance and insurance costs are also sharply higher, although much of the curse is taken off these factors by the ability of aeroplanes to roll up the ton-miles at a rate several times that of any other freight carrier. An indication of the cost of air transport is furnished by the charter cost for a "DC-3" transport—85 dollars per hour. Even allowing for the greater effective capacity permitted by the aeroplane's speed, this is several times the cost of a truck, although a freight aeroplane, without passenger luxuries and depreciated over a longer period, would be substantially less expensive than the passenger transport. However, in competing on a price basis, air freight lines would have to meet the low competitive rates possible to railways.

The largest sources of air express revenue at present are mechanical and electrical parts, printed matter and merchandise, in that order. Wearing apparel and motion picture film are the two most important individual items. The average shipment weighs about 7 lb. and travels over 800 miles, or more than twice as far as the average passenger. The Railway Express Agency now handles all services connected with air shipments except the actual flying, thus minimising the aeroplane's inability to duplicate the truck's pick-up and delivery service, particularly serious because of the customarily remote location of airports. In addition, Railway Express sends a shipment part of the way by rail, if such a procedure leads to faster delivery; 30 per cent. of air express packages are so treated.

The rapid and continuing increase in air express shipments, which permit same-day or overnight delivery to any part of the country, indicates that the time saving which the aeroplane affords outweighs higher transportation costs for a growing list of articles.

* From *Industrial Bulletin of Arthur D. Little, Inc.*, May, 1941

1000-kW Windmill

WORK has progressed so far that in a few weeks the largest aero-electric power generating unit ever built, and the first to supply alternating current for commercial use, will go into service. The installation is being made on top of a 2000ft. mountain, Grandpa's Knob, near Rutland, Vt., and will tie into the power system of the Central Vermont Public Service Corporation.

The entire wind power plant is balanced on top of a structural steel tower, 110ft. high, 36ft. square at the base, and anchored into the mountain top with a steel grillage and concrete foundation, 23ft. deep.

A heavy plate steel girder structure, called the pintle girder, forms the foundation for the plant. It inclines downward toward the wind at an angle of 12·5 deg. so that the turbine shaft makes a similar angle to the horizontal. The blades and their control mechanism overhang one side of the tower and approximately balance the rest of the equipment on the other side. The blades, constructed of stainless steel, are over 11ft. wide by 65ft. long and weigh 15,300 lb. each.

A heavy structural steel hub post about 16ft. long projects at right angles to the main shaft and is securely attached to it by a central hub. Each blade is supported by its shank from the hub post by a heavy structural steel A frame hinge. Structural steel coning struts tie the outer ends of the A frames to one end of crank arms pivoted in the downward end of the hub, which extends out about 10ft. from the hub post. The other end of the crank arms connects to hydraulic cylinder pistons that act as oil dashpots to stabilise the coning of the blades under the impact from gusts of wind.

The blades have three motions: first, they are driven by the wind to rotate the main shaft at 28·7 r.p.m. Since the blades span 175ft. a speed of 28·7 r.p.m. gives them a tip speed of 15,785ft. per minute, compared to around 6000ft. per minute for a propeller type hydraulic turbine.

When the blades are being driven at normal speed centrifugal force holds them at nearly right angles to the main shaft. If a sudden gust of wind hits them they can cone down wind to a maximum of 20 deg. to relieve the initial shock and assist the governor in regulating speed. As previously mentioned, speed is regulated by the governor changing the pitch angle of the blades into the wind. Change in blade pitch angle for normal operation will be about 30 deg., but a range of 99 deg. has been provided for research purposes.

Two double roller bearings 12ft. apart on the pintle girder support the turbine shaft, which is about 24in. in diameter. The turbine shaft is coupled to a double helical gear unit that increases its speed to 600 r.p.m. that of the generator. The generator is rated 1000 kW at 80 per cent. power factor, 2300 volts, 60 cycles, three-phase.

Labour in the Aircraft Industry*

THE Sub-Committee have spent several months in investigating some of the conditions and problems of labour in factories engaged in aircraft production, and have taken evidence from aero-engine manufacturers as well as from the airframe and equipment sections of the industry. In order to obtain reliable information based on experience in all parts of the country, representatives of firms and factories situated in different areas have been invited to appear before the Sub-Committee. Evidence has also been heard from the Ministry of Labour and private individuals.

TRAINING

The Sub-Committee have made some inquiries into the proportion of skilled to semi-skilled and unskilled labour in the aircraft industry. There seems to be wide variation. They were told that in the works of a firm of aero-engine manufacturers skilled men made up about 50 per cent. of the entire labour force; while in a firm of airframe constructors less than 30 per cent. appeared to represent skilled labour. But at the present time, when dilution and upgrading are in operation everywhere, the distinction between grades of workmen is hard to draw and comparisons are of little value. The Sub-Committee have already expressed their doubts whether all skilled labour is properly employed, but it seems clear that there is no trained labour in the engineering industry now unemployed. The Sub-Committee have therefore heard some evidence on the subject of training.

The bulk of the training of labour for the aircraft industry, both training of new labour and upgrading, takes place in the factories. Some firms have small training schools designed to produce the fully skilled man. The majority content themselves with training raw labour in single operations and assembly work. But considerable use is also made of the Government Training Centres. It has been suggested that the Ministry of Labour are providing a form of training which is too slow and too elaborate for the needs of the aircraft firms. It has also been said that the Employment Exchanges seek to divert to a lengthy course of instruction in the centres new labour which, if sent straight into the factories, could be engaged in productive operations of a simple character within a few days. It has been suggested that the instructors in the centres are not up to date in productive methods. It is fair to the Ministry of Labour to say that the majority of the witnesses who have appeared before the Sub-Committee have expressed satisfaction with the type of trainee they have received from the centres and have paid tribute to the degree of co-operation which exists in most districts between centres and employers.

WAGES

The Sub-Committee have taken some evidence on the wages now being paid in the aircraft industry. Stories are told in the Press and elsewhere of operatives taking away each week very large sums of money, and the Sub-Committee were prepared to find that earnings in general were unduly high. The evidence that has been given them does, in fact, show that the aircraft section is probably the highest-paid section in the engineering industry. The great demand for aircraft which resulted from the successive expansion programmes of the last few years meant a great demand for skilled labour. Efforts to draw the best men into aircraft construction inevitably took the form of offering attractive wages. This has had a number of bad effects. It has tended to upset wage rates and the normal movement of labour within the engineering industry generally. It has also tended to break down collective control and direction of the industry, and has weakened authority. But the Sub-Committee have not found that average earnings in aircraft firms are as extravagant as is popularly supposed. There will always be cases where a man in one week may have an accumulation of bonus due to him which will swell his pay packet out of all proportion to his average. It is usually these cases, which, in fact exceptional, are taken to be typical, that give rise to tales of excessive rates. There will always be a few outstandingly good and quick workmen who can make a regular wage much in excess of their fellows, wherever piecework is in operation. There will always be a time, if a firm has enjoyed a long period of straight run production, when all reasonably efficient pieceworkers have become so entirely familiar with their jobs that they can earn a wage in excess of their normal expectations. But they will suffer proportionately when production changes. The Sub-Committee were told that in one firm of aero-engine manufacturers there might be twenty men who earned between £12 and £13 in any given week and perhaps 100 men taking between £11 and £12. But the average wage for the highest-grade worker in the same firm did not appear to exceed £7 per week, and it must be remembered that many thousands of workpeople are employed in their factories. In a firm of airframe constructors the average weekly wage of a coppersmith was £8 15s. where the maximum was £9 15s., of a toolmaker £8, with a maximum of £8 14s., and of a fitter £6 5s. with a maximum of £9. These wages are undoubtedly high. The Sub-Committee have no quarrel with high wages as such. Men are working long hours, in most cases sixty hours or more a week. When the money is well earned as a result of skill and energy, the firm which pays those wages obtains as a result of them high production. But they have had evidence of firms in the aircraft industry deliberately paying their operatives more than the agreed district rates and, by so doing, disturbing other firms in that district. The Sub-Committee are not referring here to the payment of small "merit" advances in particular cases, but to a general practice of overpayment throughout a factory. They have heard of a case where a firm, which was paying these excessive wages, wished to transfer to another firm, which observed the proper rates, some skilled workers surplus to their own requirements. They had great difficulty in effecting this most desirable transfer because the men were unwilling to accept the substantial drop in earnings which would be entailed. This is a state of affairs which the Sub-Committee deplore, and they urge most strongly that the Ministry of Aircraft Production should do everything in their power to ensure that factories working for them, either commercially or on a management fee basis, observe the Federation rate and keep their bonus percentages in line with those of their neighbours.

CONTROL OF LABOUR AND ABSENTEEISM

The Sub-Committee turn from a consideration of wage rates to aspects of the labour situation which are closely connected with wages; that is to say, (*a*) control of labour, and (*b*) absenteeism. They have taken evidence on both these subjects.

In regard to labour control, the Sub-Committee have been told by employers of the difficulties in the way of production when firms are always liable at any moment to lose key men. In normal times, change of employment is entirely legitimate. If a man is offered work nearer his home or work that gives him a chance to better himself, which would not be open to him in his present job, then it is reasonable that he should be allowed to take it. But the nation is at war, and the drift of labour from job to job in the hope of temporary financial benefit, which has resulted from unscrupulous firms bidding against each other for personnel, has long been felt to be intolerable. The Ministry of Labour attempted to solve the problem by the introduction of the Restriction on Engagement Order,† which sought to prevent employers in the engineering industry from engaging labour except through the exchanges. The fact that a firm, if a man left them whom they wished to retain, could represent to the exchange that he was vital to their production and ask that he should be refused other employment in the industry, was supposed to force the man to return. In practice, there was a loophole in this provision, because men could still obtain employment through the trades unions. In effect, even if a man were compelled to return, he was often disgruntled and an unwilling worker. The method of control has therefore been completely changed. The Essential Work Order‡ recently issued applies, subject to certain requirements of fair wages and conditions, to all undertakings which the Minister of Labour may schedule as engaged in essential work, and provides for due notice of intention to leave or dismiss, for a hearing before an official of the Ministry, for appeal against his decision, and ultimately, if necessary, for direction under penalty. There has, as yet, been no experience of the working of this Order. The Sub-Committee have, however, had evidence to show that firms in the aircraft industry welcome a development on these lines.

The Essential Work Order also seeks to deal with absenteeism. The Sub-Committee have had some very disturbing evidence on this subject. The representatives of the firms who have appeared before them have almost all referred to it as their most serious problem. It appears to be causing the loss of thousands of man-hours every week throughout the country. Some firms have reported regular percentages as high as 10 and 12 per cent. The Sub-Committee have seen figures showing that in some weeks the percentage in certain firms has been as high as 20 per cent. As a general rule, in the first months of the year attendance at work almost invariably shows a decline. Ill-health and bad weather are contributory factors. In time of war, enemy action through the effect of air raids on communications and public services may also become an important factor. Severe damage in any area is bound temporarily to affect attendance. Unavoidable absenteeism will vary, but, subject to exceptional circumstances, may reasonably be expected not to exceed 5 per cent. It is the avoidable percentage with which the Sub-Committee are here concerned. They have been told that the two principal causes of this evil are (i) the high level of wages now general throughout the industry, and (ii) Sunday labour.

In an earlier paragraph the Sub-Committee have recorded their view that wages in aircraft factories are high, though not so high as is commonly supposed. The fact that a man can easily earn enough for his immediate requirements will tend to make some workmen relax their efforts and even absent themselves altogether after a certain point has been reached, particularly when the fruit of their endeavours beyond that point goes in an ever greater proportion to the State by way of income tax. Although these men are a minority, there will therefore always be some deliberate absentees whether there is Sunday work or not.

But the matter is complicated by the fact that a seven-day week is now in general operation throughout the aircraft industry. Work is therefore not remunerated at a level rate. No man can work continuously without a break. When a man can earn double time on Sunday, it is not surprising that, if he is tired, he will absent himself on a week-day with the feeling that he is not greatly the loser on balance. Firms recognise that their workpeople need relaxation. Some firms have sought to meet the difficulty by the operation of an eight-day roster of attendance. Other firms give alternate Saturdays and Sundays off. The Sub-Committee realise that some Sunday work, by way of repairs and maintenance of plant and for similar essential purposes is unavoidable. They are not at the moment concerned with this. But where work on any considerable scale is regularly continued on a Sunday there will be men earning money which is a direct incentive to absenteeism on other days. The seriousness of the situation lies in the fact that the unauthorised absentee does not only penalise his firm by the loss of his own work; his absence affects the output of others, and the balance of production may be materially disturbed. The attitude to Sunday labour of the firms which have been examined by the Sub-Committee has varied. Some have expressed the opinion that, with a six-day week, their production would suffer. But the majority have stated explicitly that, on balance, Sunday work is of no value. These firms have been in a difficult position. They have been pressed by the Ministry of Aircraft Production to work a seven-day week and required to achieve a high rate of production. They have felt impelled to work on Sundays, but they have lacked any means to deal with the absenteeism which they have known to be largely the result of Sunday work. They have hesitated to dismiss absentees, partly because it was difficult to be sure that absence was avoidable and partly because they needed the men's work, even if it was uncertain. It may be that some absenteeism results from a genuine grievance of the workers against the management, but the Sub-Committee received no evidence supporting such a suggestion. There are now provisions under the Essential Work Order to deal with absentees, whatever the cause of their bad attendance. A firm can report persistent offenders to the National Service Officer in the local labour office. He then summons the men to explain their absence and investigates their reasons. If the officer considers that there is no excuse for absence he directs the men to attend at work. There is a right of appeal, and, ultimately, penalties to meet failure to comply. There has been no experience yet of the working of these provisions. It is to be hoped that they will be effective. In view of the evidence they have heard, the Sub-Committee are convinced that a general direction to aircraft firms to work a seven-day week over a long period, regardless of their particular problems and circumstances, does little to speed production, and has, in fact, seriously disturbed organisation in the factories and increased costs. They urge therefore that Sunday labour, except for maintenance and repair of plant and other essential purposes, should be discontinued.

The Sub-Committee have also had some evidence on the subject of bad time-keeping. Most firms have told them that, compared with absenteeism, this is not a serious problem. It is recognised that transport conditions due to shortage of omnibuses and from time to time to enemy action are responsible for much late attendance. But there is an impression that some workmen habitually make lack of travel facilities an excuse. Firms have attempted to meet transport difficulties by the staggering of hours, but there is a limit beyond which this device cannot usefully be employed. Managements have complained that they have had no remedy. Men who are earning the good wages now paid in the industry do not mind the loss of a few moments in the morning. Firms eager to obtain a high production are reluctant to close their gates. The Essential Work Order attempts to deal with the problem of the persistent bad time-keeper, in the same way as with absenteeism, through the agency of the National Service Officer. If the procedure under the Order proves effective in operation against the greater evil, it should be able to deal with the lesser.

NIGHT WORK

The attention of the Sub-Committee has been drawn to the subject of night work. It appears that

* Excerpts from the Fifteenth Report from the Select Committee on National Expenditure.

† S.R. & O., 1940, No. 877.
‡ S.R. & O., 1941, No. 302.

firms in the aircraft industry are working night shifts wherever these can be arranged. Some of these shifts are only a very small percentage of the day shifts. Where work at night on any considerable scale does take place, there seems to be some conflict of opinion on its value. One firm told the Sub-Committee that their production at night from an equal number of workers was only 60 per cent. of day production. Where firms have complained of a decline in output from their men at night, it has been said that the reasons are largely psychological. It has also been suggested that it is more difficult to obtain effective supervision at night. There will generally be some men in any factory who prefer working at night. The Sub-Committee have gained the impression that, unless a firm are lucky enough to have a large number of such employees in their works, there is bound to be some proportionate fall in production at night. But they doubt whether the figure of 40 per cent., which was quoted to them, is general, and it is clear to them that, wherever men can be induced to work in sufficient numbers to keep essential plant in operation, night work must continue.

LABOUR DISPUTES

The Sub-Committee wish to refer to one other aspect of labour in the aircraft industry of which mention has been made in the course of evidence—industrial disputes and subversive activity. They are glad to know that disputes have been infrequent and unofficial, usually confined to a small section and capable of rapid solution. They have been told of only one case where workers in any number stayed out for more than a few days. There is no doubt that, where local conditions give rise to grievances, there is an element in the country which is ready to exploit the situation and foment trouble. All the witnesses who have appeared before the Sub-Committee, however, have agreed that the element is very small and, though active, so well known to managements throughout the country that to restrict their influence presents little difficulty.

Compaction of Cohesionless Foundation Soil by Explosives*

By A. K. B. LYMAN, M. Am. Soc. C.E.†

INTRODUCTION

FRANKLIN FALLS DAM, on the Pemigewasset River, near Franklin, N.H., was designed for the control of floods on the Merrimack River. In their natural state at this site there are deposits of loose, fine alluvial sand, especially in the river terraces of the foundation area of the embankment that constitutes a part of the project development. Extensive investigations disclosed that the stability of the embankment would be considerably increased if these loose sand deposits could be consolidated to reduce the possibility of their failure by liquefaction due to disturbance caused by earthquakes, demolitions, or blasting in the vicinity.‡ Estimates of cost were prepared for various compaction methods, including that of driving piles and the use of large vibrators and tamping equipment to reduce the voids ratios of the loose terrace materials below critical values, as defined by Arthur Casagrande, Assoc. M. Am. Soc. C.E. Consideration was also given to the excavation of the loose materials and replacement by the same or other materials in a dense state by accepted compaction methods. The uniformly high cost of the treatments considered led the writer to investigate the feasibility of compacting the loose deposits by use of buried charges of explosives.

As a necessary prerequisite to the application of this method to compaction of loose soils, it is necessary to consider—(*a*) type of soil, (*b*) condition or degree of saturation of soil, and (*c*) depth of deposit. Although compaction by blasting was initially developed for the treatment of loose deposits of uniformly graded, slightly silty, fine to medium sands at Franklin Falls, subsequently sands containing a substantial percentage of silt have been successfully compacted at one other locality.

Saturation of the soil to be compacted, at least in the region of the explosive charges, is regarded as conducive to the best results. However, fairly effective compaction has been obtained in tests at the Denison, Tex., dam under conditions of partial saturation. The pore water probably acts initially as a tamping medium, thus facilitating the progression of the vibratory waves or shocks emanating from the charges. The explosion of buried charges induces a "liquefaction" of the soil mass, followed by an escape to the ground surface of excess pore water, which acts as a lubricant to facilitate a rearrangement, in a more compact state, of the soil grains in the vicinity of and overlying the charge. Extensive explorations after blasting disclosed the absence of cavities which may have been created momentarily by blasting in the soil mass.

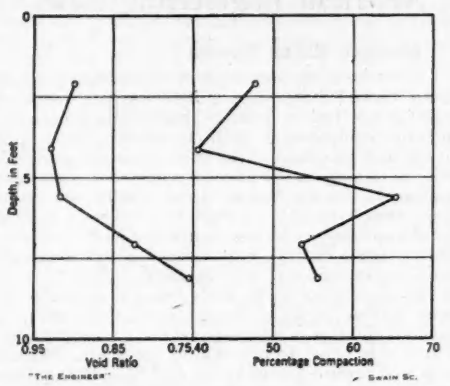


FIG. 2—*First Test Area, Test Pit* 609*; Voide Ratio* versus *Depth*

There are no apparent limitations to the depths of deposits that may be consolidated by means of explosives. On the contrary, deposits of sand at considerable depth may be compacted in this fashion, whereas they may not be readily accessible to other forms of treatment.

It is thought that where loose strata of sand greater than 30ft. thick are to be compacted, two or more tiers of small charges are to be preferred to one tier of large charges. For deposits less than 30ft. thick, charges at depths, below the top surface of the mass to be compacted, of approximately two-thirds of the thickness of the loose soil mass, will generally suffice.

The size and distribution of charges should be such as to shatter the soil mass thoroughly, but not to the extent of creating permanent surface craters. A surface crust of impervious material inhibits the emission of the surplus pore water from the ground, and must be disturbed, fractured, or removed. Following the dull thudding sound of the blast there is an upheaval of the ground surface in the range of influence, a fracturing of the surface, and the escape of gas and water for periods of from minutes to hours from crater-like openings similar to sand boils which appear on the surface. The primary surface settlement immediately follows the initial upheaval, and continued settlement is apparent for a few minutes. No doubt settlement continues for some time as part of the adjustment of the soil mass accompanying the continuing expulsion of surplus pore water.

The lateral distribution of charges should be based on results obtained from a series of single shots. A horizontal grid spacing of charges, 20ft. on centres, for the initial coverage, with an orderly interspersion of four subsequent coverages in the space intervals between prior coverages, proved satisfactory at Franklin Falls.

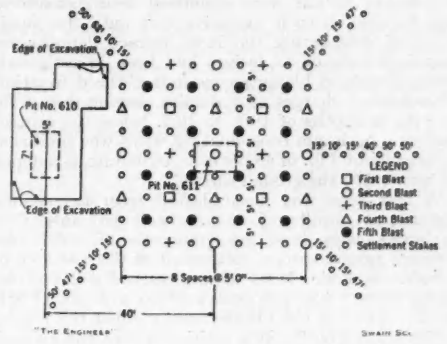


FIG. 3—*Lay-out of Second Test Area*

The degree of compaction obtained by blasting can be demonstrated by tests of undisturbed samples taken before and after the compaction operation. Undisturbed sampling below the ground water table, although requiring expensive test pits, is necessary if the results are to be evaluated accurately. Observation of ground surface settlement by means of stakes or anchored plates permits a generalised interpretation of the effectiveness of the blasting method. Moreover, such observations indicate the settlement for each blasting coverage, and hence are a key to the number of coverages required.

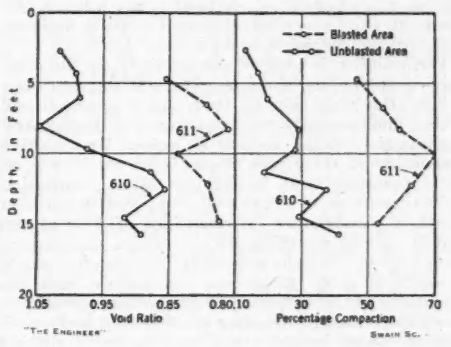


FIG. 4—*Second Test Area, Test Pits* 610 *and* 611*; Voids Ratio and Degree of Compaction* versus *Depth*

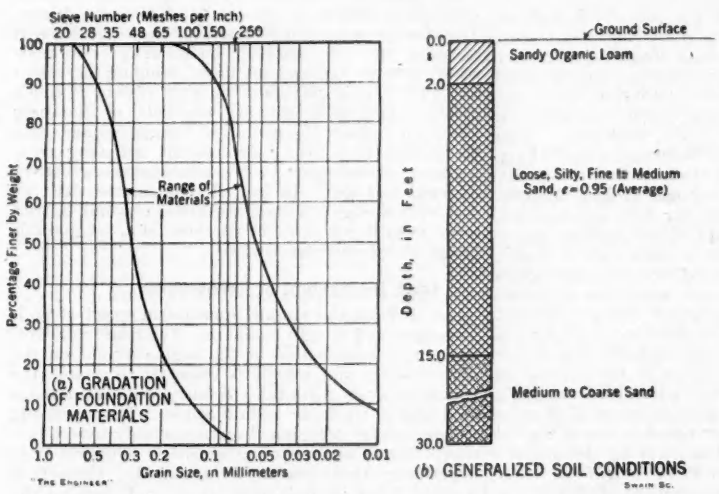


FIG. 1—*Soil Characteristics, Franklin Falls Dam*

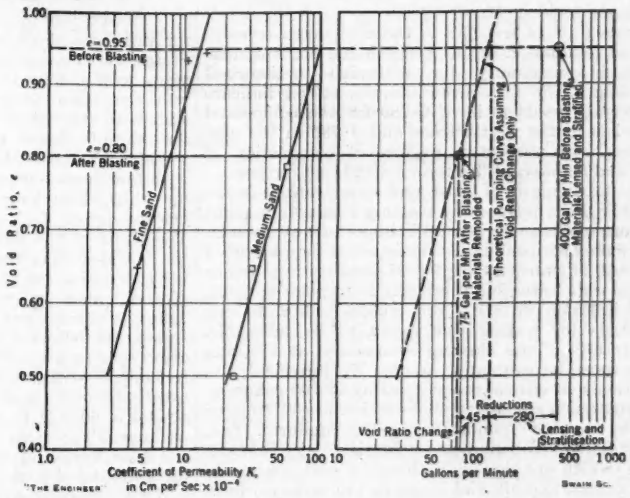


FIG. 5—*Laboratory Permeability Curves on Remoulded Samples; Field Pumping Test*

TESTS AT FRANKLIN FALLS DAM

The Franklin Falls embankment is of rolled earth design, about 1700ft. long and 130ft. high (maximum), with a height of approximately 110ft. above the terraces.

The embankment foundation area consists in part of two overbank flood plains or terraces, each about 400ft. wide, of loose, fine-to-medium, alluvially deposited sands, extending to depths of from 15ft. to 30ft. Below this stratum are stable coarse sands and gravels. As construction of the dam proceeds, the loose, cohesionless materials will consolidate slightly, but not sufficiently to reduce the fine materials below their critical voids ratios for the loads to be imposed. Apprehension was felt that these deposits might suddenly "liquefy" and flow from

* American Society of Civil Engineers.—Abstract.

† Col., Corps of Engrs., U.S. Army, 3rd Engrs., Schofield Barracks, Hawaii.

‡ *Civil Engineering*, April, 1940, page 205.

beneath the embankment, due to disturbance caused by earthquakes, slides, settlements, or vibrations. Fig. 1 (*a*) indicates the range of grading, and Fig. 1 (*b*) the distribution of the critical materials in the river terraces.

Alternate remedies to eliminate the hazard of foundation failure were dismissed from consideration because of their excessive cost until the possibility of compacting the loose terrace deposits by buried charges of explosives had been investigated. Preliminary test blasting consisted of the detonation of individual charges of dynamite ranging from 2 lb. to 8 lb. at depths of 10ft. to 16ft. below the ground surface; optimum consolidating effect was produced by charges of 8 lb. of 60 per cent. dynamite at a depth of 15ft. below the ground surface.

A test area was next blasted with twenty-one charges at depths of 15ft., distributed into four coverages with final grid intervals of 10ft. An average ground surface settlement of the test area of 1·25ft. resulted. Tests of undisturbed soil samples taken from a test pit excavated to a depth of 8ft. in the centre of the blasted area yielded the results indicated in Fig. 2. It is estimated that the average voids ratio before blasting was 1·0 and the degree of compaction 36 per cent.

To confirm these results and further develop the method, a second test area, with five blasting coverages (see Fig. 3), resulted in an average ground surface settlement of 2ft., the compaction being effective over an estimated depth of 20ft. Pits were excavated before and after blasting. Tests of undisturbed soil samples indicate changes in voids ratio and degree of compaction as plotted in Fig. 4. No evidence of cavities was revealed by the test pits excavated after the blasting operations. A total of six soil samples taken at each elevation indicated a fairly uniform degree of compaction laterally at each depth.

Permeability is reduced substantially by the compaction operations, and is attributable to two causes —first, the reduction in void spaces between soil grains, and, secondly, the breaking up of lensing and stratification of the natural deposits. The relative magnitude of these two effects is shown in Fig. 5. Field pumping tests before and after compaction operations from identical well point systems around two test pits resulted in quantities of flow of 400 and 75 gallons per minute respectively. Laboratory tests indicate that the reduction in voids ratio would account for only 45 gallons per minute, and the remainder of the reduction of 280 gallons per minute is attributed to the breaking up of lensing and stratification which indicates the importance of altering this characteristic of highly permeable soil deposits.

As a result of these tests, it was concluded that the loose sand terraces could be compacted satisfactorily by blasting methods. Each of the terraces, measuring approximately 400ft. by 850ft., was compacted by using a total of 12,000 explosive charges. On the west terrace the average ground surface settlement was 2ft. in a depth of 20ft. of loose materials. On the east terrace where the loose materials extended to an average depth of 25ft., the settlement was greater, averaging about 2·5ft.

Excavation of trenches in the compacted terraces for the foundation drains beneath the embankment afforded opportunity for extensive undisturbed sampling. The fifty-seven samples tested indicate an average voids ratio of 0·780 for the compacted materials in the west terrace and 0·736 in the east terrace, with respective degrees of compaction of 45·7 and 56 per cent. for the west and east terraces.

The breaking up of lenses and stratifications in the Franklin Falls terraces by blasting results in a slight mixture of the material and is important as a means of reducing permeability. Undisturbed samples (after blasting) of sufficient size for tri-axial testing present such a wide variation of grading from point to point that isolation of the more critical uniformly fine materials for testing was found to be infeasible. The results of the blasting compaction at Franklin Falls must be evaluated in part by judgment and experience in critical density testing of fine cohesionless materials similar to those which are of concern in the terrace foundations. The uniform, fine, cohesionless embankment materials at Franklin Falls (which are similar in character and grading to the critical, fine alluvial sands in the terraces) have been tested extensively, and, for the design loadings, a critical voids ratio of 0·67 has been determined. Although not subject to strict correlation, the voids ratios in the terraces, after blasting (with values as low as 0·656, but generally ranging from 0·72 to 0·80), may be favourably compared with those of the mechanically compacted embankment. It is manifest that a comparison of these voids ratios provides considerable assurance that dangers of liquefaction have been reduced greatly.

The cost of compacting the Franklin Falls terrace foundation is approximately 35,000 dollars, or 0·09 dollar per yard, for the material compacted. This compares with a minimum estimated cost of 125,000 dollars for treatment by other methods.

[Tests were also made at Denison dam, Texas, and at Almond dam, Hornell, N.Y. Details are given in the complete paper.]

SUMMARY

The method, in brief, consists of the detonation of charges of explosives spaced laterally and vertically throughout the loose soil mass. Successive coverages of the same area give additional compaction, but the limits of compaction for a specific material by this method have not been investigated. Neither have the tests to date been extensive enough to show whether optimum results are obtained in fully or partly saturated soil.

It can be stated definitely, however, that the present indications are that the method is widely applicable to loose, cohesionless structural foundations, provided the materials are substantially saturated prior to blasting. In addition to increasing the degree of compaction of the materials, the horizontal permeability of stratified deposits is greatly reduced.

American Engineering News

American Mining Progress

One of the developments in mining practice in the United States during 1940 was the increased use of motor lorries, tractors, bulldozers, excavators and other equipment for highway construction in open pit mining operations. In such open pit work for iron ore mining on the Mesaba range conveyors have been used. On the Morenci range electric shovels or excavators with 23-yard buckets have been loading end-dump motor lorries operating automatically under remote control, but electrically operated cars are being introduced, and the entire railway system of the open-mine workings is being electrified. In shaft sinking a novel feature is in unwatering in advance of the excavation by means of pumping from a drill hole bored to one side of the shaft. With a deep well turbine pump in the drill hole 4300 gallons per minute have been removed against a head of 480ft. Diamond drill work is on the increase, with speeds up to 7200 r.p.m., this advance being due largely to the introduction of bortz bits. In rock drilling detachable bits are more widely used, except at works so extensive that sharpening of drill steels is a large-scale operation. An interesting work is the drilling of the Carlton Tunnel in hard granite for the drainage of a large district to enable a group of deep mines near Cripple Creek to be sunk to greater depths. A heading 10ft. by 11ft. has been advanced 78ft. in a twenty-four-hour day and 1879ft. in thirty-one consecutive days. The tunnel will be 6 miles long. For deep mines where increasing temperatures of the rock render normal ventilation inadequate, special coolers have been introduced. Air drawn in by a fan at 95 deg. wet bulb and 105 dry bulb is delivered at the working face—800ft. distant—at 88 deg. and 109 deg. respectively, the rock in this case having a temperature of 146 deg. Fah. Mucking machines, belt conveyors and improved narrow-gauge equipment are promoting speed and economy in underground haulage.

New American Steamers

IN the programme for active shipbuilding for private and Government service in the United States, two interesting steamers of entirely different types were put into service in March. One of these was the train ferry steamer "City of Midland," added to the fleet of such vessels operating on the 85-mile route across Lake Michigan. This vessel, for the Pere Marquette Railroad, is 406ft. long, with four tracks on the main deck, having a capacity for thirty-four long double-bogie freight wagons. On the upper deck is space for fifty automobiles. The latest of the older boats of this railway are of the turbo-electric type, with motors on the shafts, but this newest has two enclosed reciprocating engines of the "unaflow" type, each with five cylinders, 25in. by 30in., and running at 120 revolutions. Lump coal delivered to the bunkers is carried by pan conveyors to a roller crushing machine, and thence to hoppers with screw conveyors to the hoppers of overfeed stokers under the water-tube boilers. With a total of 6000 H.P., the ship has a speed of 18 miles an hour. The other steamer noted is one of six for the New York and Africa Line, serving eleven ports on a scheduled route. It is 480ft. long, 66ft. beam, and 27ft. draught, with a displacement of 15,000 tons, and a speed of 16 miles an hour. Primarily a cargo boat, it has elaborate accommodations for twelve passengers, and is intended for a round-trip route of 20,300 miles. A cross-compound, double-reduction geared turbine of 6300 H.P. drives the single screw at 85 r.p.m. The high and low-pressure turbines each drive a high-speed pinion through a flexible coupling. An astern turbine is enclosed in the casing of the low-pressure turbine. Steam at 450 lb. pressure and 740 deg. Fah. temperature, with 28½in. vacuum, is supplied by two water-tube boilers. Special attention is given to the ventilation of cabins, refrigeration holds, and mechanical cargo-handling equipment.

American Army Tank Building

In the vast amount of munition plant factory construction undertaken in the United States, two features of note are the specialised designs and the rapid construction. An example is the Detroit ordnance plant, covering nearly 700,000 square feet in area and planned to produce five 25-ton Army tanks daily. The contract was let on August 15th, 1940. Plans were then prepared, ground was broken on September 11th, steel erection began on November 19th, and the placing of roof tiles on December 9th. Before the end of December the entire plant was enclosed, and the installation of machinery had been begun, while on February 10th men began work on the construction of the first tank. The main building, one storey high, is 1380ft. long and 500ft. wide, of steel construction, with monitor or clerestory ventilating bays along the roof, while glass forms 95 per cent. of the wall surface. Along one side is a bay, 60ft. wide, with a railway track and unloading platform for the reception of materials. From this bay extend a series of 60ft. production bays, crossing the building to an assembly bay, 80ft. wide, along the opposite side of the building. In the long 60ft. bay the columns are spaced 20ft. centres, and the clear headroom under the roof trusses is 30ft. The spacing is the same in the long 80ft. bay, but the headroom there is 40ft. In the transverse bays the column spacing is 60ft. and 45ft., and the headroom is 21ft. Concrete is used for the column footings and the machine foundations, some of the latter carrying 25-ton loads. The floor area has an 8in. concrete base with creosoted wood block flooring. The main lines of water piping, sewers, and electric conduits are kept outside the building, with laterals to the interior. Interior piping laid along the roof trusses include steam, compressed air, oil for machine tools, propane gas for cutting torches, and hot and cold water for toilet and locker rooms. Overhead electric cranes handle material. Other buildings of the plant include a four-storey office building and a boiler house. A "figure-eight" test track provides for a 75-mile run with each tank.

New Type of Suspension Bridge

As a result of extended tests and investigations following the destruction of the Tacoma suspension bridge, a new type of bridge has been designed in which crossed diagonal braces are introduced in each panel or bay formed by the vertical hangers from the cables. With this addition to the normal or conventional design, the structure is a complete truss, with the cable forming the upper boom and the stiffening girder the lower boom, while the suspension cables and the new diagonals constitute the web members. This rigid truss structure resisted the attempts to build up a vibration amplitude or undulation. The diagonal members were pre-stressed so that they were always in tension, owing to carrying the load of the floor system. In the model tests the static deflection curves show that these deflections are greatly reduced by the new braced suspender system, and that the typical tendency toward negative or upward deflections in the model of conventional construction is eliminated by the truss type of action in the model of the new system. A comparison of cable vibrations with node at centre, which is the main form of vibration that causes failure of the cables, shows a rapid damping effect of dynamic loading, and it appears to be reasonably certain that no wind or other dynamic load could build up an appreciable resonant vibration in the model of the new design. The change in structural action of the cable when it becomes the top chord or boom of a continuous truss is surprising, and the great damping increment due to the new suspender or web system is much greater than with ordinary methods of damping vibrations. Since the cable and hangers constitute a continuous truss, the conventional stiffening truss becomes unnecessary, with consequent saving in material and cost. In fact, it is estimated that the cost of a bridge on the new system would be not more than 1 per cent. of the cost of a comparable bridge of conventional design.

Load Distribution of Locomotives

With the marked increase in speed of both passenger and freight trains on American railways, the proper distribution of the engine weight on the several axles and wheels is essential to enable the engine to work at its full efficiency, without damage to bridges, track or rolling stock. The unsprung weight can be determined approximately by calculation. But as to the sprung weight, it is known from experience that variations from the theoretical weights occur on individual axles, and even on the two wheels of a given axle. Furthermore, the distribution of these weights will change as the engine travels along the line, unless the springs are accurately adjusted. For accurate knowledge as to the actual weights on locomotive wheels, the Illinois Central Railroad has installed a wheel-load track scale of the plate fulcrum type at its Paducah shops. Its total weighing capacity of 450 tons is divided between eighteen units—nine under each rail—each unit having a capacity of 25 tons. The arrangement of the units allows all wheel loads of any locomotive to be weighed with one spotting of the engine. In this type of track scale the usual knife-edge bearings are replaced by plate fulcrum pivots securely attached to the connecting levers. The scale is 60ft. long, in a concrete pit, in the floor of which are embedded two pairs of 14in. H beams or rolled joists to support the bases of the scale units. Hardened steel rails are used on the scale. Under capacity load the depression of the weigh rail or scale rail is only 0·006in. Weights can be read in increments of 20 lb., and an interpolating pointer indicates when the scale is in balance,

so that the weights can be estimated to within 10 lb. The movement of the extreme end of the weigh beam is only 0·4in. between no load and full load positions. The live rails on which rest the individual wheels are separated by lengths of dead rails. In operation all wheel weights are taken three times.

BRITISH STANDARDS INSTITUTION

All British Standard Specifications can be obtained from the Publications Department of the Institution at 28, Victoria Street, London, S.W.1. The price of each specification is 2s. 3d. post free, unless otherwise stated.

AUTOMATIC DETECTION OF INCENDIARY BOMBS

BS/ARP 55. It will be recalled that a report by a committee set up at the request of the Ministry of Home Security to investigate the methods available for the detection of incendiary bombs was recently published by the Institution of Electrical Engineers. In this report it was stated that the information given therein would be supplemented from time to time by the issue of British Standard Specifications. A B.S. specification for detectors of the heat-sensitive type was issued by the British Standards Institution as BS/ARP 53 a few months ago, and this has now been followed up by the issue of a specification BS/ARP 55 for "Detectors of Incendiary Bombs by Electrical Circuits Ruptured by Impact." This applies to detector systems in which a bell or other alarm is caused to operate by the impact of a falling bomb causing the rupture of a special "detector conductor" forming part of a closed electrical circuit. Systems of this sort are stated to be primarily intended for installation in buildings such as dwelling-houses and small industrial or commercial premises, and if the specification is complied with the bomb will be detected immediately on arrival and before a fire has been started. The special "detector conductor" is passed backwards and forwards over the area to be protected, and full directions for the spacing and arrangements of the conductor are given. The mechanical properties of the conductor are specified in detail, as it is essential that the wire breaks and does not merely stretch when hit by a bomb. From this point of view plain soft copper wire is definitely unsuitable, but hard-drawn copper wire of gauge 28–32 S.W.G. will meet the prescribed tests.

As the system works on the closed-circuit principle a relay must be used, and its reliability is a matter of particular importance. Details of suitable relays are given at some length, together with appropriate circuit diagrams.

This specification should appeal to the home constructor, as well as to those who manufacture or instal detector systems on a commercial scale. Copies (Ref. BS/ARP 55) may be obtained from the British Standards Institution, 28, Victoria Street, London, S.W.1, price 8d. post free.

Copies of the report referred to earlier in these notes may also be obtained from the offices of the British Standards Institution, 28, Victoria Street, London, S.W.1, price 6d. post free.

PORCELAIN AND TOUGHENED GLASS INSULATORS FOR OVERHEAD POWER LINES

No. 137—1941. With a view to bringing the British Standard Specification for Insulators for Overhead Power Lines into line with the international standard published by the International Electrotechnical Commission, a revision was undertaken some time ago and the results of the work have now become available with the publication of the 1941 edition of B.S. 137. Toughened glass insulators are included as well as porcelain. This is an advance on the I.E.C. specification, which is still applicable to porcelain only, but there has been sufficient experience in this country of the use of toughened glass insulators to enable a specification to be established. The performance tests are, in general, common to porcelain and toughened glass, but certain tests are peculiar to each type. For example, a porosity test is prescribed for porcelain, but not for glass, and a toughening test is prescribed for glass, but not for porcelain. Another new feature of the specification is an appendix dealing with ball and socket fittings for suspension insulators, the dimensions of which have been standardised with a view to securing interchangeability. An appendix on the selection of insulators has been entirely rewritten in the light of experience during the last few years.

SILVER SOLDER

No. 206—1941. This revision of B.S. 206, Silver Solder, Grades A, B, and C, includes a further type of solder of the quaternary alloy class (*i.e.*, containing silver, copper, zinc, and cadmium), which is now being increasingly used in industry. An appendix has been included for general information, which gives the melting range of the three grades of solder covered by the specification.

LEADED BRONZE CASTINGS AND INGOTS

No. 960–965—1941. These specifications have been based on proposals prepared by the Institute of British Foundrymen. The specifications follow the lines of similar standards that have been prepared for gun-metal and leaded gun-metal castings. They provide for three alloys, which are designated as follows:—85/10/0/5 Leaded Bronze, 80/10/0/10 Leaded Bronze, 76/9/0/15 Leaded Bronze. For each alloy separate specifications are given for ingots and castings. The numbers represent the percentages of copper, tin, zinc and lead respectively. The absence of zinc is indicated so as to differentiate these alloys from the gun-metal alloys of the type covered by B.S. 898–901.

ENGINEERS' GENEROSITY.—Lord Nuffield and Sir Alfred Herbert have each subscribed £20,000 to help to restore the services of the Coventry and Warwickshire Hospital, Coventry. In rather more than a month more than £72,000 was raised.

Markets, Notes and News

The prices quoted herein relate to bulk quantities. Unless otherwise specified home trade quotations are delivered f.o.t. Export quantities are f.o.b. steamer

Concentration of the Tinplate Industry

A short time ago the then President of the Board of Trade referred to the concentration of industrial plant with a view to increasing production. It appears probable now that this policy will be applied to the tinplate industry, which under present conditions is not operating at anything like capacity. The necessity of restricting quantities of steel used in the manufacture of tinplate owing to its diversion to more urgent uses has naturally affected the industry sharply. There is, however, a good demand for tinplates in many of the world's markets. In some cases the British authorities have arranged for supplies to British Dominions to be filled by the United States, but in one or two instances arrangements have been made to send supplies of tinplate abroad on the understanding that it is for packing food which will be imported into Great Britain. Apparently it is intended to organise the works by concentrating production, and the Minister of Supply has appointed the following as a Committee to consider and report on the application to the tinplate industry of the policy of concentration of industry, having regard to the measure of redundant plant existing in the industry:—The Rt. Hon. The Lord Essendon, J.P., Chairman; Captain H. Leighton Davies, C.B.E., J.P. (Chairman of the Tinplate Conference), Mr. J. E. James (Richard Thomas and Co., Ltd.), Major Llewellyn David (D. R. David and Co.), Mr. John Brown (Iron and Steel Trades Confederation), Mr. P. Owen (Transport and General Workers' Union), Mr. R. G. Lewis (National Union of General and Municipal Workers). Mr. J. C. Carr, Raw Materials Department, Ministry of Supply, The Castle, Warwick, will act as Secretary to the Committee.

The Pig Iron Market

There is a steady demand for pig iron of all descriptions, but supplies are well maintained to firms employed on Government work. On the North-East Coast the production of foundry pig iron has practically ceased, as the makers are concentrating upon the production of basic iron for the steel works. A few small tonnages of foundry are produced now and again, and these are promptly taken up by consumers, who, however, are supplied for the most part by the Midland foundries. All the heavy engineering foundries in the Midlands are fully employed, and are likely to remain so for many months. The tightness in the supply of hematite and low phosphoric pig iron continues, but with the home production supplemented by imports and the use of refined and high phosphoric pig iron as substitutes wherever possible the position is not difficult. The light castings foundries are still short of work, and it has not been found possible to absorb so large a proportion of the industry in the war effort as was at one time hoped. The production of high phosphoric pig iron in the Midlands is sufficient to meet all requirements, and supplies of this quality are being sent to most other districts by the Midland producers. In Lancashire the heavy electrical and machine tool industries are big consumers of pig iron. Supplies, however, are carefully arranged by the Control and appear to be reaching the consuming works with regularity. Firms employed upon unessential work, however, are not finding it easy to obtain their full requirements, but lately there has been a speeding up of deliveries to firms employed on essential contracts, and the position is regarded as satisfactory. Some improvement has been noticeable in the Scottish light castings industry, and many of the firms are busier than of late. Most of the supplies for this branch of the trade now come from the English Midlands, and are adequate to meet all the demands. The activity in the shipbuilding yards is reflected in busy conditions at the heavy engineering foundries.

The Midlands and South Wales

The production of iron and steel in the Midlands, as in other districts in Great Britain, has attained a high level, and the steel works are fully employed. As most of the allocations for the third quarter delivery have been placed, the steel makers will be occupied at capacity for a long time, and few of them are in a position to accept fresh business. The careful supervision of distribution by the Control and the restriction of steel allocations to any but essential uses has naturally further curtailed the quantities available for ordinary commercial purposes. It is realised, however, that in time of war the country's resources must not be dissipated on any work which is not of national importance, and although there may be some grumbling, the position is accepted. The structural engineering concerns in the Midlands are for the most part well placed as regards work, and practically all of them are employed upon Government contracts. It is suggested that the structural engineering trade is not so well employed as early in the year, but it is absorbing considerable tonnages of joists and other structural steel. The demand for plates has not relaxed and large quantities are going to the shipyards. The tank makers, boilermakers and wagon builders also have a large amount of work on hand, and are eagerly taking delivery of as much material as they can obtain. Firms engaged upon essential work find that their supplies reach them with regularity, and there have been no reports of unnecessary delays. The insistent demand for steel bars which has characterised the market for some time is now exercising an influence upon the position, which has become somewhat tight in the case of the larger sizes. The call for special steels which has been noticeable for some weeks appears to be expanding, and great efforts are being made to maintain production. There is a big demand for cold-rolled strip and bright drawn bars, and in the case of some of the special qualities deliveries are rather extended. There is no change in the situation in South Wales, and the works are fully employed upon Government contracts. The heavy steel makers are being pressed to the limit to maintain regular deliveries, but delays are not serious. The demand for billets is particularly strong, and a great deal of imported material is being distributed. The production of British billets, however, has reached a high level. There is a moderate demand for tin-plates, but the restriction on production checks business. The demand for sheets has become rather quieter.

Scotland and the North

The steel-consuming industries in Scotland are working under great pressure, and practically all are engaged upon war work. The steel works are supplied with sufficient orders to keep them employed for a long time to come, but it is noticeable that in some directions new business is not coming forward in the same volume as in the earlier part of the year. Consumers who are not engaged upon war work do not find it easy to obtain all the material they require. The Control has tightened up its machinery, and if ordinary civilian needs have been restricted, it is reported that firms engaged upon urgent Government work are finding the situation much easier. It is reported that the tonnage of unexecuted orders carried forward from delivery period 2, which ended on June 30th, was much smaller than had been expected, but substantial contracts have been placed for execution in the third delivery period, which ends on September 30th. The works are understood to have more than sufficient orders in hand to occupy them during the current quarter. Pressure to obtain plates is unrelaxed, and large tonnages are being turned out. The quantities passing to the shipbuilding yards show no signs of diminishing, and there is a strong request from the tank and boiler-making section of the market. With all the engineering establishments occupied upon some form of war work there is a particularly heavy demand for bars of all sizes. The marine and general engineers in particular are busy, and their requirements of bars, sections, and castings represent a heavy tonnage. In the Lancashire district the demand for structural steel is not more than moderate, although it is suggested that it is better than was the case during May. The falling-off is principally noticeable in the case of heavy joists and sections, but large tonnages of the lighter descriptions of structural steel are passing into consumption.

Copper and Tin

The copper position has not changed to any great extent over the past few weeks. In Great Britain the Control carefully watches over the distribution of the metal, but supplies are sufficient to enable all the requirements of the war industries to be met and there appears to be no anxiety on that score. Consumption is at a high level, as large tonnages of the metal are required for war purposes. In the United States the position is steady, but apparently there is no surplus copper to export excepting to Allied countries. The licensing system in America is carefully enforced and there is little likelihood of any leakages to countries favourable to the Axis Powers. In fact, the American industry requires all the copper produced in the United States to meet domestic needs and for use for the rearmament programme. No export figures are now published in the United States and it is thought that the authorities may exert their influence to stop the publication of production statistics. The smelting and refining plant at Hoboken, in Holland, has been unable to operate at capacity owing to a shortage of raw materials. Normally this plant deals with considerable quantities of raw material from the Belgian Congo, but latterly these supplies have decreased. Nothing so far has been heard of Russia's requirements of copper, but it is anticipated that these will be on a considerable scale. . . . In the tin market prices have fluctuated and at times have shown a definitely easier tendency as a result of sales by smelters. The market has become very narrow and transactions of little importance are therefore quickly reflected in the price. Some disappointment is felt that Russia has made no move to obtain supplies of tin, as it was expected that her requirements would be large. It would, of course, be possible for Russia to buy direct from the East and transport the metal over the Siberian Railway. There seems little expectation of any violent movement in prices, but on the whole the view is held that production for the time being is greater than consumption. The fact that no export licences are available in this country is also a factor in keeping the tin market on the quiet side.

Lead and Spelter

The world's lead position appears to be growing steadily tighter. In Great Britain supplies arranged on the outbreak of war are sufficient to provide all the lead required by the war industries; but there are indications that the Control is tightening up its distribution and that firms who are not engaged upon essential work will find it more difficult to obtain supplies. In the United States the lead position is stringent and large tonnages are passing into consumption in the defence programme. Reports are current that the Government in the United States is trying to obtain supplies from Mexico and South America and imports of 20,000 tons are talked of. This transaction would, of course, be undertaken by the American Metal Reserves Company. According to statistics published in the United States, imports of lead last year were upon a high scale and from Mexico alone totalled nearly 129,000 tons, against 294 tons in the previous year. . . . The spelter position is tight in most of the consuming countries. In Great Britain the situation has to be carefully watched by the Control, but those firms employed upon war work are obtaining all the metal they need. At the same time, the possibility of tighter conditions developing cannot be lost sight of, and efforts are being made to increase the home production of the metal. In the United States, although the position remains stringent, prices are unaltered at 7·25c., East St. Louis, but this is due to the attitude of the American Government, which is averse to any increases in the price of metals. According to American figures, the June production was 62,200 tons and the deliveries 63,150 tons. At the end of June the stocks were 7400 tons, compared with 8300 tons at the end of May.

Notes and Memoranda

Rail and Road

A NOTABLE CENTENARY.—Thomas Cook, born in 1808 at Melbourne, Derbyshire, organised and carried throughgon July 5th, 1841, the first public railway excursion promoted by a private individual and so initiated a world, famous travel enterprise.

HOW GERMANY TRANSPORTS WAR MATERIALS.—A recent inquiry has made it plain that Germany has appropriated approximately 45,000 Belgian railway trucks, while only a few of the 78,000 lorries that Belgium possessed before the German invasion are now available for use. Meantime Germany is utilising the existence of the railway carriage and wagon building industry in Belgium to the fullest extent.

A BRIDGE WITH A SHORT LIFE.—The Ontario authorities have authorised the demolition of a highway steel and concrete bridge at Calamity Gulch, two miles north of New Liskeard. This bridge replaced an older wooden structure that had done duty for many years. The present bridge was begun in 1934 and was completed and ready for use in the following year. Subsequently its floor level was disturbed by "slides" and in recent months this "dip" about halfway across the structure had become pronounced in character.

AMERICAN TIME TABLES.—What are described as "brilliant-hued, vest pocket size time tables" of trains operating between New York and main line New England cities have just been issued by the New York, New Haven and Hartford Railway Company. In addition to schedules of trains, information concerning coach and Pullman fares and photographs of types of equipment featured on the various trains are included. As the booklet measures 4¼in. by 3in., one is prompted to ask how many pockets there are in an American waistcoat.

AGRICULTURAL TRACTORS.—Recently in the House of Lords, the Duke of Norfolk stated that there are now 90,000 tractors engaged in British agriculture, whereas in 1938 the number in Great Britain was estimated at less than 40,000. The two chief countries of the world relying on the agricultural tractor are the United States and Soviet Russia. It is thought the latter country has now about 500,000 tractors at work, many of them in very large collective farms, whilst as far as can be made out there are about 1,500,000 tractors operating in the United States.

ACCIDENTS AT LEVEL CROSSINGS.—From figures just issued by the U.S.A. Interstate Bureau of Statistics, there was a sharp rise in deaths from railway train operations in 1940. Accidents at rail highway crossings brought death to 1808 persons and injuries to 4632, as compared with 1398 deaths and 3999 injuries in 1939. Casualties were thus 19·33 per cent. above those of the previous year, while the number of crossing accidents was up 18·07 per cent., from 3476 to 4104. The fatalities and injuries in these accidents represented 40·68 and 26·38 per cent. respectively, of all fatalities and injuries in 1940 railway accidents resulting from train operation.

LET THE PASSENGER DECIDE.—A New York suburban line recently got its own passengers to help in the compilation of the current time-table. Shortly before daylight saving time came into effect this year, patrons received a questionnaire asking them to choose the time for departure of the last run from Jersey City, N.J., terminal, and to note other suggestions. Returns from these enabled the railway to adapt itself better to the needs of its patrons—without added expenditure of funds. A later departure time was provided for the evening steam train out of Jersey City. A morning commuters' train was speeded up to arrive in Jersey City 2 min. earlier, enabling passengers to board a ferry landing them in New York more than 10 min. sooner.

L.N.E.R. MEDAL.—The London and North-Eastern Railway has approved the design of a medal for employees who show outstanding courage and resourcefulness in circumstances which, had they been connected with enemy action, would have warranted recommendation for Government recognition. The medal is of silver, and bears on one side the shield of arms of the company imposed on a laurel wreath encircled by the words "London and North-Eastern Railway." On the reverse side is a scroll on which the name of the recipient will be engraved. This is supported by two sprays of laurel, the whole superimposed on an arc of the rising sun showing radiating lines of light upwards and outwards. Round the circumference is inscribed, "For Courage and Resource."

Air and Water

DANISH SHIPS IN AMERICA.—According to reports from New York, the U.S. Maritime Commission has taken over another sixteen Danish cargo ships, thereby adding 95,000 tons of shipping to the American defence fleet. Two of the vessels are to be turned over to the Army and the others will be used for transporting defence materials from South and Central America.

LONDON'S WATER SUPPLY.—It has recently been stated that a scheme has been evolved for linking the water resources of the Metropolitan Water Board with those of adjoining authorities in the Home Counties. This scheme is part of a plan to ensure that no portion of the area shall, on account of enemy action, run the risk of water scarcity for domestic use or fire-fighting purposes.

INDIAN SHIPBUILDING.—News has been received of the laying of the foundation stone of the first modern shipbuilding yard in India by Mr. Rajendra Prasad, Acting President of the Indian National Congress. The yard, which was constructed by the Scindia Steam Navigation Company, is expected, when fully developed, to turn out sixteen vessels annually. It is expected that the first ships will be launched before the end of 1942. The yard is being constructed on a 55-acre site near the harbour of Vizagapatam, which is considered the most suitable for the venture as it has the requisite depth of water.

MAGNESIUM FOR AIRCRAFT.—The U.S.A. Bureau of Mines is pushing on research work at its Pullman laboratory in the hope of simplifying production. The U.S.A. aircraft industry accounts for most of the structural magnesium alloy products employed. The trend in aircraft construction is to use even greater quantities of magnesium alloy per plane. The alloy goes into engine, wheels, and airframe, and other structural parts. The munitions industry to-day also requires more magnesium to manufacture tracer bullets, star shells, flares, and certain bombs.

PORT OF NEW ORLEANS.—A record volume of tonnage was handled at the port of New Orleans last year, according to a report of the United States Army Engineers. This report stated that a total of 19,795,599 tons of cargo moved through the port during 1940, and exceeded a previous high record by more than 2¼ million tons. Total imports for New Orleans aggregated 2,896,269 tons, while exports totalled 3,351,177 tons. The coastwise movement for the year amounted to 5,366,326 tons, which included shipments of 3,554,471 tons and receipts of 1,811,755 tons. Internal receipts were shown by the report as 5,240,960 tons and internal shipments were 2,940,867 tons. Vegetable food products were the principal item of import. Other principal imports included animals and animal products, 82,986 tons; vegetable products, inedible, 119,411 tons; textiles, 131,596 tons; wood and paper, 83,018 tons; non-metallic minerals, 375,238 tons; ores, machinery, and vehicles, 169 tons; and chemicals, 96,730 tons. Non-metallic minerals took the lead in exports with a total of 1,225,765 tons. Other exports included ores, metals, and manufactures, 656,358 tons; machinery and vehicles, 175,996 tons; chemicals, 84,964 tons; animals and animal products, 33,063 tons; vegetable food products, 259,764 tons; vegetable products, inedible, 106,052 tons; textiles, 358,286 tons; and wood and paper, 438,794 tons.

THOMAS GRAY MEMORIAL TRUST.—Under the Thomas Gray Memorial Trust, the objects of which are "the advancement of the science of navigation and the scientific and educational interests of the British mercantile marine," the Council of the Royal Society of Arts offers a prize of £50 to any person who may bring to its notice an invention, publication, diagram, &c., which, in the opinion of the judges, is considered to be an advancement in the science or practice of navigation, proposed or invented by himself in the period January 1st, 1936, to December 31st, 1941. Entries which have already been considered by the judges in the years 1936–40 are not eligible for further consideration unless they have since been materially modified. The Council reserves the right of withholding the prize or of awarding a smaller prize if, in the opinion of the judges, no suitable invention is submitted, and in the event of more than one such improvement being approved, the Council reserves the right of dividing the amount into two or more prizes at its discretion. The Council does not claim any rights in respect of any invention to which a prize may be awarded. Competitors must forward their proofs of claim between October 1st and December 31st, 1941, to the secretary, Royal Society of Arts, John Adam Street, Adelphi, London, W.C.2.

Miscellanea

PETROL FROM WASTE.—The Government of Southern Rhodesia contemplates the erection of a plant with a daily output of 3000 gallons of ethyl alcohol from surplus and waste agricultural products; the output would save other motor fuel.

STEEL FOR HAND TOOLS.—All applications for authorisations for the purchase of steel for hand tools should henceforth be addressed to the Directorate of Hand Tools, The Cedars, Tettenhall, Wolverhampton. The definition of a hand tool for this purpose is "a tool operated by hand not requiring mechanical power to drive it."

CHEMICALS FOR PLASTICS.—The Office of Production Management in America has requested that whenever possible plastics be substituted for such strategically important metals as aluminium and magnesium. Unfortunately, the expansion of the plastics industry is limited and will probably continue so owing to shortage of raw materials.

PANEL FOR GLASS FIRMS.—The Glass Manufacturers' Federation has established a defence panel to advise on scientific, technical and allied problems relating to glass, which may arise during the war. The chairman is Professor W. E. S. Turner, of Sheffield University, and the address of the Director of the Federation is "Orleans," Latimer Road, New Barnet, Herts.

AUSTRALIA ROLLING ALUMINIUM SHEETS.—The Australian Aluminium Company, formed two years ago and jointly owned by the British Aluminium Company, Aluminium, Ltd., of Canada, and the Electrolytic Zinc Company of Australasia, is now producing aluminium alloy sheets from ingots imported from Canada. Extensions to the works, to be equipped with Australian-built machinery, are in progress.

REORGANISED APPRENTICE TRAINING SCHEME.—In view of the importance of continuing and developing programmes for training engineers in spite of the war, the Brush Electrical Engineering Company, Ltd., of Loughborough, has recently reorganised its apprentice training scheme. We recently received from the firm a brochure describing the new arrangement, and no doubt it would be available to all those interested on application to the firm. To enable students of limited means to take advantage of one of the new courses, the "College Apprentice Sandwich Course," the firm is offering scholarships to the value of £75, tenable for four years, the first to be spent in the works and the remaining three at any British university.

FUSE-FILLING PLANT.—Canada's war effort is reflected in the news that nearing completion on the outskirts of Toronto is a fuse-filling plant which has cost 3½ million dollars. It will eventually employ several thousand men and women, and increase Toronto's annual industrial payroll by 3 million dollars.

UPROOTING INDUSTRY.—Mr. Leonard G. Ting, of the Nankai Institute of Economics, has collected and published some information about the transference of works in China due to Japanese war aims. In one area, and over a comparatively short period, the total number of privately-owned plants which were removed was 146, of which no fewer than sixty-six were engaged in the production of machinery and metals. Over 2500 skilled workers and nearly 15,000 tons of equipment and materials had to be moved.

TWO LAMPS—ONE LIGHT.—The G.E.C. of America has devised a circuit whereby an inoperative lamp may be automatically replaced electrically, but not mechanically, by an operative lamp. The method utilises the known fact that when two similar discharge lamps of approved type are connected in parallel through a single ballasting unit, one will ordinarily start more readily than the other, and will burn alone. Only one of the two lamps will normally start and it will operate until that lamp fails, whereupon the second lamp will come into operation.

COAL RESEARCH.—Plans have been initiated in America for a series of conferences between the directors of the leading coal research laboratories of the country. The first has been held at Battelle Memorial Institute, Columbus, Ohio. Battelle was selected for the initial meeting so that the directors might become acquainted with the programme of research being conducted at the Institute by Bituminous Coal Research. The work is sponsored by the National Coal Association and obtains its financial support by voluntary contributions from that organisation, local associations, individual producers and coal-carrying railways.

THE LATE MR. P. H. STEVENS.—We regret to have to announce the death at Northampton of Mr. Percy Herbert Stevens, a director of the Express Lift Company, Ltd., one of the associated companies of the General Electric Company, Ltd. Mr. Stevens had for nearly fifty years been connected with the Express Lift Company and its amalgamated company, Smith, Major and Stevens, Ltd., and was one of the country's foremost lift engineers. Mr. Stevens was also a director of the Law Land Company, and for many years took an active interest in the affairs of the Lawn Tennis Association of Great Britain, of which he was a Past-Chairman.

Personal and Business

MR. A. H. H. ROBSON has succeeded Mr. A. C. Grandison as publicity manager of the Union-Castle Line.

BARIMAR, Ltd., informs us that its address is now 22–24, Peterborough Road, Fulham, S.W.6.

MR. HAROLD HEATH has resigned his directorships with Humber, Ltd., of Coventry, and its associated companies.

MR. H. W. SWANN, Senior Electrical Inspector of Factories, has been re-elected President of the Association of Supervising Electrical Engineers.

SIR JOHN ROWLAND, a former Chief Commissioner of Burma Railways, has been appointed Director of Construction of the Burma-Yunnan Railway.

THE Minister of Supply has appointed Sir Walter Layton, Director-General of Programmes, to be Chairman of the Executive Committee of the Supply Council.

MR. R. F. MORRILL, joint signal engineer, London Passenger Transport Board, has been elected a Vice-President of the Institution of Railway Signal Engineers.

HON. GEOFFREY CUNLIFFE has joined the Industrial and Export Council as a business member. He has relinquished his post as Aluminium Controller to the Ministry of Aircraft Production, but is still available for consultation.

THE Minister of Aircraft Production announces that the board of Vickers-Armstrongs, Ltd., has agreed to release Mr. Alexander Dunbar to take up the appointment of Director-General of Materials Production. Mr. Dunbar has been director in charge of the Vickers aviation companies. He is a director of the English Steel Company and of Vickers-Armstrongs.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

Diesel Engine Users Association

Wednesday, July 30th.—Caxton Hall, Caxton Street, S.W.1. Heavy Oil Engine Working Costs Report, 1939–40. 2.30 p.m.

Physical Society

Friday, July 25th.—Science Museum, South Kensington, S.W.7. Charles Chree Address, by Professor S. Chapman. 5 p.m.

Royal Meteorological Society

Saturday, July 19th.—49, Cromwell Road, South Kensington, S.W.7. Discussion on Thunderstorm Problems. 2.30 p.m.

Staffordshire Iron and Steel Institute

Saturday, July 19th.—Station Hotel, Dudley. "Non-metallic Inclusions in Steel: Quantitative Evaluation," W. H. Hatfield and G. W. Giles; and "Intercrystalline Cracking in Boiler Plates," C. H. Desch. 3.30 p.m.